Environmental
Restoration
University of California
Environmental Science and Waste Technology (E)
Environmental Restoration, MS M992
Los Alamos, New Mexico 87545
505-667-0808/FAX 505-665-4747

U.S. Department of Energy
Los Alamos Area Office, MS A316
Environmental Restoration Program
Los Alamos, New Mexico 87544
505-667-7203/FAX 505-665-4504

Date: May 31, 2001
Refer to: ER2001-0468

Mr. John Young, Corrective Action Project Leader
Permits Management Program
NMED – Hazardous Waste Bureau
2905 Rodeo Park Drive East
Building 1
Santa Fe, NM 87505-6303

SUBJECT: SUBMITTAL OF RCRA FACILITY INVESTIGATION REPORT FOR MATERIAL DISPOSAL AREA H

Dear Mr. Young:

Enclosed please find two copies of the "RCRA Facility Investigation (RFI) Report for Material Disposal Area (MDA) H at Technical Area (TA) 54". This report is submitted in response to your letter dated December 27, 2000, requiring the Los Alamos National Laboratory (LANL) Environmental Restoration (ER) Project to submit a stand-alone RFI report for MDA H.

We look forward to our staff's continued High Performing Team engagement in identifying and resolving all issues regarding the report. Please contact John Hopkins at (505) 667-9551 or Woody Woodworth at (505) 667-5820, if you have any questions.

Sincerely,

Julie A. Canepa, Program Manager
Environmental Restoration Project
Los Alamos National Laboratory

Sincerely,

Theodore J. Taylor, Project Manager
Department of Energy
Los Alamos Area Office

JC/TT/PB/ev

A Department of Energy
Environmental Cleanup Program

LA-UR-01-1208
May 2001
ER20000699

RFI Report for Material Disposal Area H at Technical Area 54

Los Alamos
NATIONAL LABORATORY
Los Alamos, NM 87545

Produced by the Material Disposal Areas Focus Area

EXECUTIVE SUMMARY

This report addresses the Resource Conservation and Recovery Act facility investigation (RFI) of Potential Release Site (PRS) 54-004, Material Disposal Area (MDA) H, at Technical Area (TA) 54 at the Los Alamos National Laboratory (the Laboratory). TA-54 is located in the east-central portion of the Laboratory on Mesita del Buey between Pajarito Canyon to the south and Cañada del Buey to the north. During the late 1950s, the Laboratory, with the approval of the US Atomic Energy Commission and upon recommendation of the US Geological Survey, selected TA-54 for the disposal of Laboratory-derived waste. Three other MDAs are located on the mesa top; they are designated G, J, and L.

MDA H is a 70-ft by 200-ft (0.3-acre) fenced area and consists of nine inactive vertical disposal shafts arranged in a line approximately 15 ft inside its southern fence. Each shaft is cylindrical with a diameter of 6 ft and a depth of 60 ft. The shafts are filled with solid-form waste to a depth of 6 ft from the ground surface. The wastes in shafts 1 through 8 are covered by a 3-ft layer of concrete placed over a 3-ft layer of crushed tuff. The waste in shaft 9 is covered by 6 ft of concrete.

From May 1960 until August 1986, MDA H functioned as the Laboratory's primary disposal area for classified, solid-form waste. Between periods of waste disposal, each shaft was covered with a steel plate that was padlocked as a security precaution to prevent unauthorized access to classified materials. Much of the classified waste was nonhazardous; however, various hazardous chemicals, radionuclide-contaminated materials, and materials contaminated by high explosives were also disposed of at MDA H. These include scraps and shapes contaminated with depleted uranium, drummed radioactive waste, fuel elements, a classified unit contaminated with tritium, plutonium-contaminated shapes, and decontamination and decommissioning scrap. The MDA will remain under the control of the Laboratory for the foreseeable future. Current activities at TA-54 are conducted under the administrative authority of Department of Energy and New Mexico Environment Department (under agreement with the Environmental Protection Agency).

The Environmental Restoration Project conducted the RFI fieldwork at MDA H from 1994 to 1995 and in Spring 2001. The objectives were to determine if contaminants had been released from MDA H, to define the nature and extent of any contaminant releases, to collect data to support and supplement existing data, and to collect data to be used in assessing potential risk to human and ecological receptors. The 1994/1995 RFI fieldwork included

- drilling four vertical boreholes around the nine disposal shafts,
- collecting and analyzing 33 core samples from the boreholes, and
- collecting and analyzing four sediment samples.

Channel sediment samples were submitted to a contract laboratory and analyzed for inorganic chemicals, cyanides, polychlorinated biphenyls (PCBs), pesticides, tritium, and radionuclides. Core samples were submitted to a contract laboratory and analyzed for target analyte list metals, cyanide, volatile organic compounds, semivolatile organic compounds, PCBs, pesticides, tritium, and radionuclides. An assessment of data quality indicated that the data were generally of good quality and sufficient for decision-making purposes.

Background comparisons (inorganic chemicals and radionuclides) and data evaluations (organic chemicals) identified methoxychlor and tritium in channel sediments and copper, selenium, several organic chemicals, and tritium in tuff as chemicals of potential concern. Methoxychlor was not disposed of at MDA H and is most likely due to routine application. Copper selenium, and organic chemicals do not appear to be related to a release from the PRS. Tritium is related to a release and is in the form of water

vapor in the subsurface. Data gathered during the RFI identified the nature and partial extent of contamination in the surface and subsurface media.

Analytical results from the RFI were used to assess the present-day impacts to ecological and human receptors. The present-day risk assessment considered the potential impacts to human health and the environment from contaminants in surface soils and sediments (i.e., methoxychlor) and air (i.e., tritium) because these media are accessible to site workers (and visitors) and ecological receptors under current site conditions. Human health and ecological screening assessments did not indicate an unacceptable risk to receptors.

Data gaps regarding the extent of tritium and volatile organic compound contamination in the subsurface and of tritium in air exist, however. Therefore, the following activities are planned in 2001 to address the remaining data gaps, fully characterize the lateral and vertical extent of contaminant releases, and bolster impact assessments for MDA H.

- Collection of additional subsurface samples to further define the lateral extent of tritium and organic chemical contamination from borehole 54-1023 and from newly drilled boreholes.
- Installation of an air-monitoring station adjacent to MDA H to monitor for tritium in air.
- Collection of a sediment sample near sample location 54-5132 at the interface of the alluvial sediments and bedrock to collect data where all the sediment accumulated over the years.
- Evaluation and incorporation of groundwater data from the unsaturated zone monitoring at MDA G, the regional saturated zone at R-22, and the ongoing TA-54 groundwater investigation.

An addendum to the MDA H RFI report will summarize the 2001 data and assess if there are any changes to the present-day risk assessment.

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1.0 INTRODUCTION

1.1 Background

Los Alamos National Laboratory (the Laboratory) is a multidisciplinary research facility owned by the Department of Energy (DOE) and managed by the University of California. The Laboratory is located in north-central New Mexico approximately 60 miles northeast of Albuquerque and 20 miles northwest of Santa Fe. The Laboratory site covers 43 square miles of the Pajarito Plateau, which consists of a series of finger-like mesas that are separated by deep canyons containing perennial and intermittent streams running from west to east. Mesa tops range in elevation between approximately 6200 ft and 7800 ft. The eastern portion of the plateau stands 300 ft to 900 ft above the Rio Grande.

The Laboratory's Environmental Restoration (ER) Project is involved in a national effort by the DOE to clean up sites and facilities that were formerly involved in weapons research and production. The goal of the ER Project is to ensure that DOE's past operations do not threaten human or environmental health and safety in and around Los Alamos County, New Mexico. To achieve that goal, the ER Project is currently investigating sites potentially contaminated by past Laboratory operations. The sites under investigation are either solid waste management units (SWMUs) or areas of concern (AOCs). In the ER Project, SWMUs and AOCs are collectively referred to as potential release sites (PRSs).

Depending on the type of contaminant(s) and the history of a PRS, the New Mexico Environment Department (NMED) or the DOE has administrative authority over work performed by the ER Project. NMED, under the auspices of the State of New Mexico, has authority over cleanup of sites with hazardous waste or hazardous constituents, including the hazardous waste portion of mixed waste (i.e., waste contaminated with both radioactive and hazardous constituents). Hazardous constituents are regulated under the Resource Conservation and Recovery Act (RCRA). The DOE has authority over cleanup of sites with radioactive contamination; radionuclides are regulated under DOE Order 5400.5, "Radiation Protection of the Public and the Environment," and DOE Order 435.1, "Radioactive Waste Management." The PRS in this report contains both hazardous and radioactive components.

NMED enforces the Hazardous and Solid Waste Amendments (HSWA) Module VIII of the Laboratory's Hazardous Waste Facility Permit, hereafter referred to as the HSWA Module (EPA 1990, 1585). The HSWA Module specifies conditions and requirements for performing ER activities. The Environmental Protection Agency (EPA) issued the HSWA Module on May 23, 1990, and revised it on May 19, 1994; the permit is currently under revision by NMED.

In accordance with the HSWA Module, appropriate corrective actions are determined through the RCRA facility investigation (RFI) process. The purposes of an RFI are to

- identify site information and collect environmental data, as necessary;
- characterize the nature and extent of any contaminant release(s) to air, groundwater, surface water, bedrock, and soil;
- evaluate the potential risk to human health and the environment; and
- support corrective measures proposals, if appropriate, for the site.

This report describes the results of the RFI of Material Disposal Area (MDA) H, PRS 54-004, at Technical Area (TA) 54 at the Laboratory. Results of the RFI are used to support recommendations for future ER activities at this PRS. The report includes site history, environmental setting, data collection and analysis, and risk assessments. Appendix A includes a list of acronyms and defines terms used in this report. Appendix B gives details of the operational and environmental setting. Appendix C describes the results

of the quality control (QC)/quality assurance (QA) process. Appendix D includes the analytical suites and results. Appendix E describes statistical analyses, and Appendix F gives the risk assessment calculations. Appendix G presents a documentation of the regulatory history and status and a summary of RFI activities, assessments, and recommendations for this PRS. Appendix H includes borehole profiles and logs. Appendix I includes cross sections of stratigraphy beneath MDA H.

1.2 Technical Area 54

TA-54 is located in the east-central portion of the Laboratory (Figure 1.2-1) on Mesita del Buey between Pajarito Canyon (south) and Cañada del Buey (north) (Figure 1.2-2). During the late 1950s, the Laboratory, with approval of the US Atomic Energy Commission and upon recommendation of the US Geological Survey, selected TA-54 for underground disposal of Laboratory-derived waste (Rogers 1977, 5707 and 5708). Since that time, TA-54 has functioned as a major storage and disposal facility with some permitted treatment for wastes generated by Laboratory operations. MDA H is one of four MDAs at TA-54 (Figure 1.2-2). The MDA, which consists of nine shafts, opened in 1960 and was used for the disposal of classified, solid wastes, some of which were residually contaminated with radioactive, hazardous, and high-explosive constituents. No waste was disposed of after August 1986, but the MDA has not yet undergone formal RCRA closure.

1.3 Objectives and Scope

The objectives of the RFI at MDA H were to

- determine if a release of hazardous waste has occurred from the MDA;
- characterize the nature and extent of contaminant releases (both hazardous waste constituents and radionuclides), if any, to the environment, based on the approved Operable Unit 1148 RFI work plan (LANL 1992, 7669) and subsequent modifications (Glatzmaier 1993, 30987) (Appendix G);
- evaluate the potential ecological and human health risks posed by exposure to contaminants under present-day conditions; and
- recommend, if necessary, additional investigations to reduce uncertainties associated with contaminant behavior and to ensure that contaminants do not pose an unacceptable future risk to human and ecological receptors.

This RFI report focuses on the potential present-day risks posed to human and ecological receptors located on top of and along the sides of the mesa. The cumulative risk from all potential sources will be evaluated in watershed reports for lower Pajarito Canyon aggregate, as identified in the approved installation work plan (LANL 1998, 62060).

1.4 Technical Approach

For the technical approach to be successful, nature and extent of contamination from a release at the site and contaminant behavior in the environment must be understood. Nature and extent refers to the types of contaminants released from the PRS and their spatial distribution within and across environmental media. Contaminant behavior refers to the fate and transport of a contaminant in the environmental media. To establish nature and extent, samples of media must be collected and analyzed and the data evaluated.

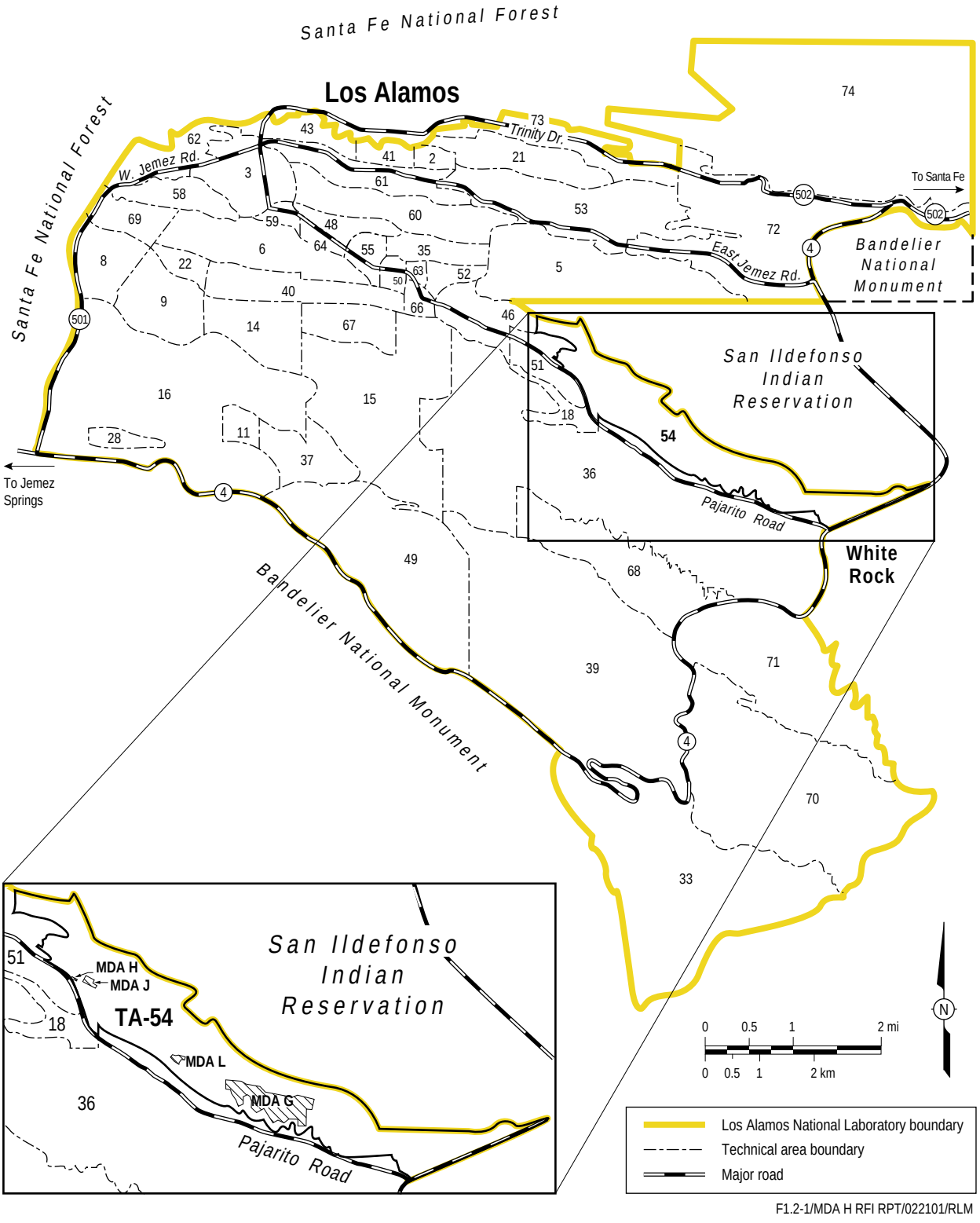

Figure 1.2-1. Location of TA-54 with respect to Laboratory TAs and surrounding land holdings

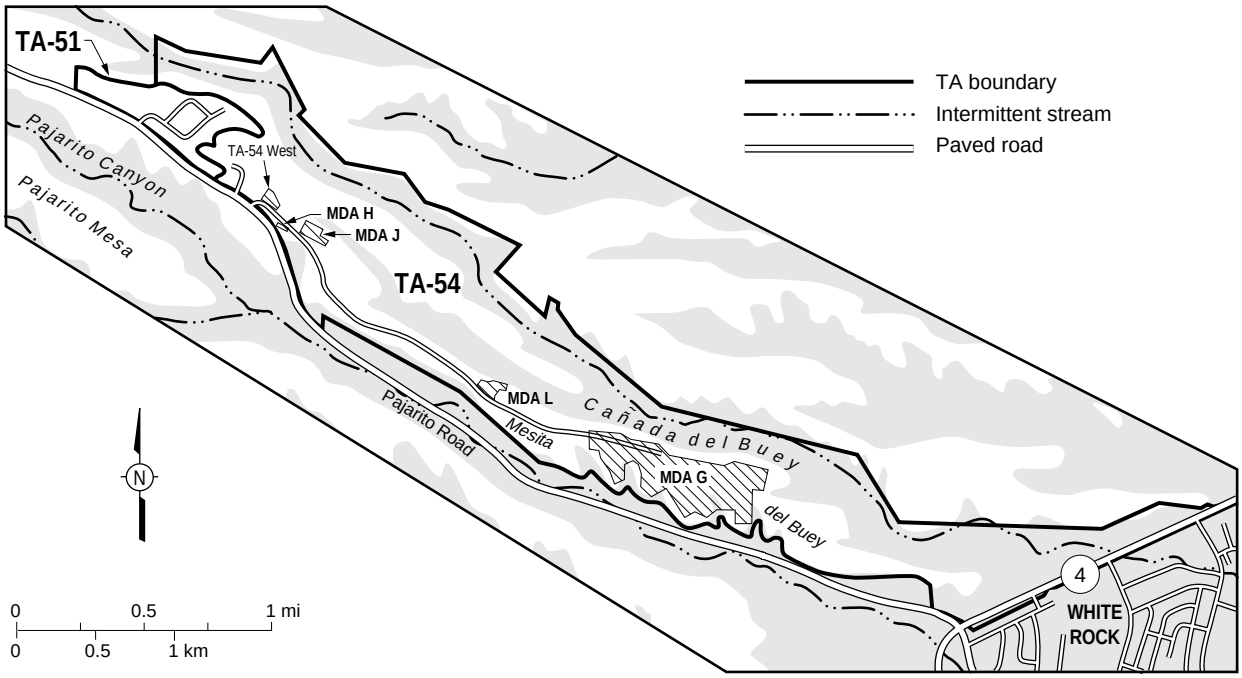

Figure 1.2-2. Location of MDAs in TA-54

The RFI of MDA H assembled existing information and undertook additional efforts to define the nature and extent of contamination from a release. Additional efforts included collecting data, revising the site conceptual model based on the new data, and estimating potential risk to human and ecological receptors from present day to 2044. Data gathered during the RFI were then evaluated to assess the potential present-day risk to site workers at MDA H. The assessments consider potential risks posed by releases of radionuclides and hazardous chemicals from the shafts to the surrounding environment. Present-day risks to biota were also assessed. A scoping analysis identified the biotic processes that were potentially most impacted by site operations and contaminant releases. Media-specific contaminant concentrations were subsequently compared with ecological screening levels (ESLs) to determine whether a potential unacceptable ecological risk existed. The approved installation work plan (LANL 1998, 62060) describes the methodologies used during the investigation and analyses.

2.0 MDA H

2.1 Summary of MDA H Activities and Data Review

From 1960 until 1986, MDA H was the Laboratory's primary disposal area for classified, solid-form waste. The MDA consists of nine inactive shafts, which are collectively designated as PRS 54-004. Shafts 1 through 8 are covered with crushed tuff and concrete; shaft 9 is covered solely by a thicker layer of concrete. All nine shafts are being addressed under RCRA corrective action.

RFI fieldwork at MDA H was conducted by the Laboratory ER Project from 1994 to 1995 to determine the nature and extent of any contamination from a release into channel sediments and subsurface media (LANL 1992, 7669). Four sediment samples and 33 core samples were collected to characterize the area

and determine if releases of contaminants had occurred. All RFI samples were sent to an off-site contract laboratory for analysis.

The RFI focused on identifying chemicals of potential concern (COPCs) and developing a conceptual model for their fate and transport. To identify COPCs, data of sufficient quality were compared with applicable thresholds (i.e., background values [BVs] for inorganic chemicals, background or fallout values for radionuclides, and estimated quantitation limits [EQLs] for organic chemicals). If sample data were above background or fallout concentrations for inorganic chemicals and radionuclides or related to a release for organic chemicals, the analytes were retained as COPCs and evaluated further.

Review of data from field investigations of MDA H indicate that the data were of sufficient quality and quantity to support the following statements:

- Most inorganic chemicals are not above background in either the sediment or tuff.
- Copper was detected at concentrations above background in the shallow tuff.
- Tritium is present at elevated concentrations in the subsurface tuff.
- Tritium and the pesticide methoxychlor were detected in channel sediments.
- Several organic chemicals were infrequently detected in the subsurface tuff.

2.2 Description and Operational History

MDA H is designated as PRS 54-004 in Module VIII of the Laboratory's Hazardous Waste Facility Permit. Additional information on site description and the operational history of MDA H is provided in Appendix B.

2.2.1 Site Description

Physical Description

MDA H is located on Mesita del Buey, a small mesa that lies between Pajarito Canyon and Cañada del Buey (Figure 1.2-2). Three other MDAs are located on the mesa top. MDA H is a 70-ft by 200-ft (0.3-acre) fenced area and consists of nine inactive vertical disposal shafts arranged in a line approximately 15 ft inside its southern fence (Figure 2.2-1). Each shaft is cylindrical with a diameter of 6 ft and a total depth of 60 ft. The shafts are filled with solid-form waste to a depth of 6 ft from the ground surface. The wastes in shafts 1 through 8 are covered by a 3-ft layer of concrete placed over a 3-ft layer of crushed tuff. The waste in shaft 9 is covered by 6 ft of concrete. To protect against the possible impacts of mesa-edge instability, all MDA H disposal shafts were located at least 50 ft from the rim of Pajarito Canyon (the nearest canyon).

Land Use

MDA H is in an industrial area currently used for Laboratory waste management. The Laboratory does not anticipate the use of TA-54 to change during the planned operational life of MDA G (2044) (LANL 1995, 57224, pp. 11–12). MDA H is a fenced area with restricted access. These security measures effectively eliminate the possibility of inadvertent site intrusion by humans.

Relationship to Other PRSs

To evaluate the potential impact of MDA H and to make sound decisions regarding the need for and nature of effective remedies, it is important to understand, at least qualitatively, the potential impact of nearby PRSs. The most significant PRSs, in terms of contaminant inventory and physical size, near MDA H are MDAs G and L at TA-54 (Figure 1.2-2) and several PRSs at TA-18 (Figure 1.2-1).

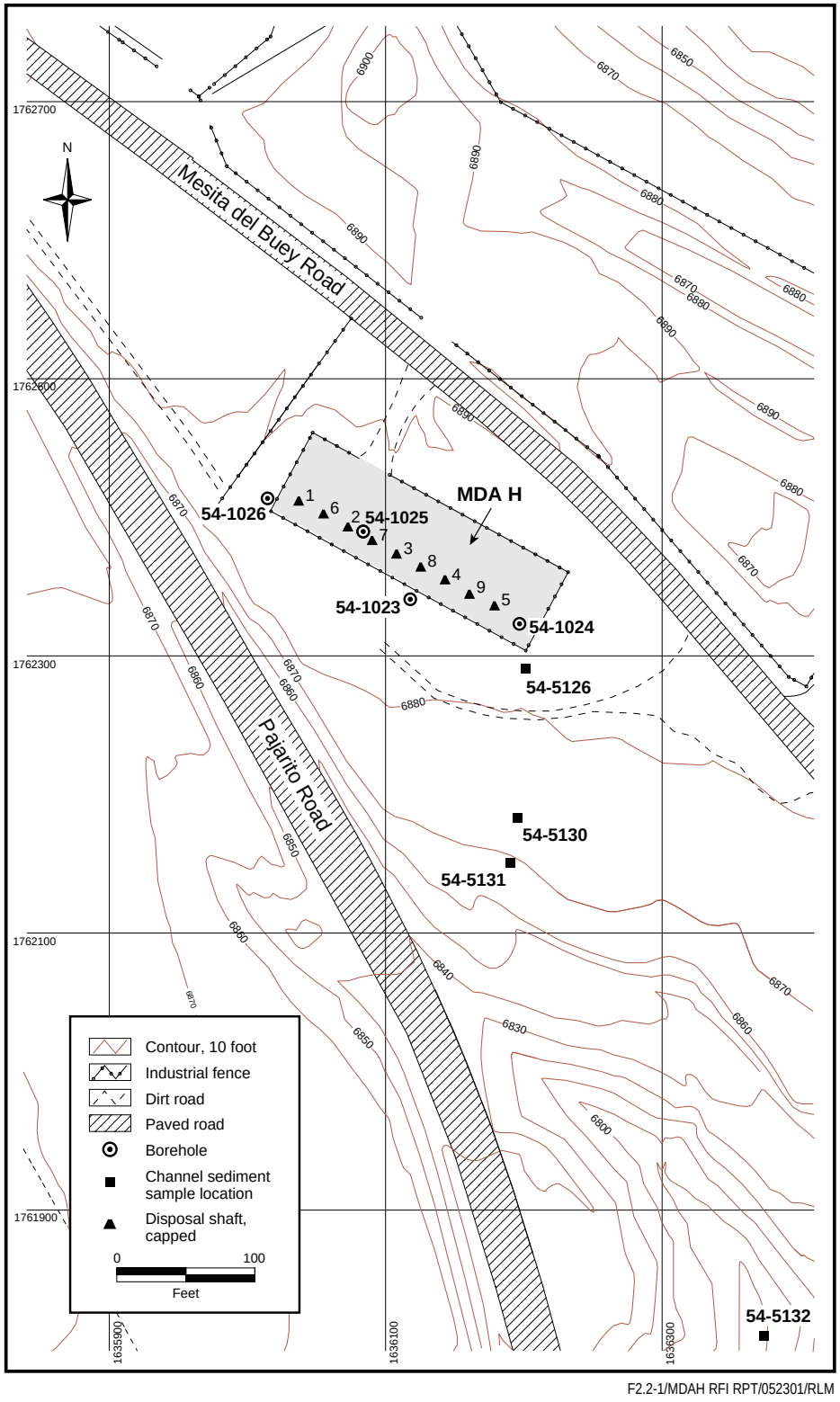

Figure 2.2-1. Locations of inactive disposal shafts, RFI boreholes, and channel sediment sample locations at MDA H

MDA G is located near the eastern end of Mesita del Buey approximately 2.3 miles (3.7 km) east of MDA H (Figure 1.2-2). This 100-acre (405,000 m^2) site has been the Laboratory's primary radioactive waste disposal facility since 1959 and is scheduled to operate through 2044. Pits and shafts at MDA G that received waste before 1989 make up 24 PRSs. Investigations to date have revealed a diffuse plume of VOCs (likely associated with residual solvent contamination in radioactive waste) and a plume of tritium-containing water vapor. As an operating nuclear facility, MDA G is subject to intensive personnel safety and environmental protection and surveillance programs, and the VOC and tritium plumes are monitored regularly. Ongoing low-level radioactive waste disposal is authorized by the DOE, and ongoing solid low-level mixed-waste and transuranic mixed-waste management activities are authorized by the DOE and permitted, as necessary, by the NMED under agreement with the EPA. MDA G is within the Lower Pajarito Canyon aggregate of the Pajarito Watershed (LANL 2000, 66802).

MDA L is a 2.5-acre (10,000 m^2) site located on Mesita del Buey approximately 0.86 miles (1.4 km) east of MDA H (Figure 1.2-2). This site has been the Laboratory's primary chemical waste disposal and treatment facility since the early 1960s. Disposal of chemical waste ceased in the mid-1980s, and the ER Project is investigating 13 pits and shafts within the Lower Cañada del Buey aggregate of the Mortandad Watershed. Early disposal activities resulted in a subsurface VOC vapor plume; since the mid-1980s, the plume has been, and continues to be, extensively monitored.

TA-18, located approximately 1000 ft (300 m) south of MDA H on the other side of Pajarito Road in Pajarito Canyon, was established in 1943 and today continues its long history in nuclear criticality research, nuclear weapons safeguards and security, and treaty verification technology assessment. TA-18 comprises 40 PRSs organized into five groups within the Lower Pajarito Canyon aggregrate of the Pajarito Watershed. Within the five PRS groups are septic systems and associated components, an underground storage tank, surface contamination from firing sites, storm sewer outfalls, and buried disposal areas (LANL 1993, 15310).

All of the proximate PRSs identified above and MDA H are located within the same groundwater aggregrate. The deep hydrogeologic system (including the regional aquifer), which for the purposes of this report means the deep subsurface beneath MDA H, is being investigated in accordance with the hydrogeologic work plan (LANL 1996, 55430) approved by NMED and the joint ER DP Monitoring Well Installation Program (LANL 1995, 50124).

Environment

Detailed information on the environmental setting of the Pajarito Plateau and TA-54 is provided in Appendix B. This section discusses only site-specific aspects of the environmental setting of MDA H; these aspects are important to assessing the potential for fate and transport of contaminants and include

- a semiarid climate with low precipitation and a high evapotranspiration rate, which limits the amount of moisture percolating into the shafts, subsequently limiting the amount of water available to leach radionuclides or other hazardous waste constituents;
- a very thick, relatively dry unsaturated zone, which greatly restricts or prevents downward migration of contaminants in the liquid phase through the vadose zone to the regional aquifer; and
- a canyon-mesa terrain, which affects atmospheric conditions and ecological habitats.

One of the Laboratory's six meteorological towers is located at MDA G and provides site-specific meteorological data for Mesita del Buey; these data are summarized in Appendix B, Section B-2.

MDA H is located on the south side of Mesita del Buey. The area is relatively flat with a gentle slope toward Pajarito Canyon to the south. Runoff is primarily by sheet flow into a tributary of that canyon. A

surface water assessment of MDA H was conducted on December 20, 2000. Based on this assessment, this PRS has a score of 45.6, indicating a moderate erosion potential. The assessment found that there was no debris in the watercourse. Surface water runoff from MDA H terminates to the southeast in Pajarito Canyon. Rill erosion is occurring at one location along the southern fence line, and there is minor run-on to the site from the northwest. There are no structural or operational factors that might affect the site hydrology. The hydrology of the general area is discussed in Appendix B, Section B-4, and the surface water assessment document is attached at the end of that appendix.

The ER Project has drilled, cored, and sampled four boreholes at MDA H to characterize the potential contaminant release and transport in the subsurface. Borehole logs provide detail on the stratigraphy below the MDA to a depth of approximately 260 ft and are included in Appendix H. Detailed discussions of the stratigraphy and the geology of TA-54 are in Appendix B, Section B-3.

The estimated depth to regional groundwater beneath MDA H is 1040 ft (312 m), which corresponds to an elevation of 5848 ft (1754 m), based on data from the Site-Wide Geologic Model 3-dimensional stratigraphic model (Carey et al. 1999, 66782). Preliminary data indicate that regional well R-22, located immediately east of MDA G on Mesita del Buey, encountered the regional aquifer within the Cerros del Rio basalts of the Puye Formation at a depth of 895 ft (269 m), which correlates to an elevation of approximately 5745 ft (1724 m). No perched zones of saturation were encountered above the regional aquifer. It is anticipated that the 3-dimensional stratigraphic model, Site-Wide Geologic Model, will undergo revision to incorporate data from R-22 by the end of Fiscal Year 2001.

Cultural and Biological Resources

No cultural resources are present at or near MDA H. Section B-6 in Appendix B presents information on the cultural resource survey for this area.

No wetlands or floodplains exist near MDA H. No habitats for threatened and endangered (T&E) species were located. Further information is contained in "Biological Assessment of Environmental Restoration Program, Operable Unit 1148, TA-54" (Banar 1996, 58192) and in Section B-5, Appendix B. The ecological scoping checklist for TA-54 is included in Appendix F.

2.2.2 Operational History

From May 1960 until August 1986, MDA H functioned as the Laboratory's primary disposal area for classified, solid-form waste. Between periods of waste disposal, each shaft was covered with a steel plate that was padlocked as a security precaution to prevent unauthorized access to classified materials. Table 2.2-1 presents a summary of the types and quantities of the wastes disposed of at MDA H. The table, which was compiled from information in the MDA H operational logbook (LASL 1960, 70034) and the Operable Unit 1148 data report (IT Corporation 1992, 23247), includes information about the period of use and the date each disposal shaft was capped. Much of the classified waste was nonhazardous; however, various hazardous chemicals, radionuclide-contaminated materials, and materials contaminated by high explosives (HE) were also disposed of at MDA H. These include scraps and shapes contaminated with depleted uranium, drummed radioactive waste, fuel elements, a classified unit contaminated with tritium, plutonium-contaminated shapes, and decontamination and decommissioning scrap. As can be seen in Table 2.2-1, MDA H also received a one-time disposal of a nonsolid-form waste when 40 lb of graphite-contaminated motor oil was placed in shaft 9. Information on the operational history of TA-54 is in Appendix B, Section B-1. A discussion of the inventory, compiled from disposal records for MDA H, follows.

Table 2.2-1
Summary of Wastes Disposed of at MDA H Shafts

	Shaft 1	Shaft 2	Shaft 3	Shaft 4	Shaft 5	Shaft 6	Shaft 7	Shaft 8	Shaft 9	MDA H Total
Period of use	5/3/60 to 9/27/61	10/17/61 to 5/15/63	6/4/63 to 11/9/64	12/23/64 to 8/16/66	10/7/66 to 9/27/67	7/12/67 to 3/6/69	3/21/69 to 9/8/71	10/4/71 to 7/16/79	7/23/80 to 8/29/86	n/a[a]
Date capped	10/11/61	Unknown	12/10/64	9/66	Unknown	3/13/69	9/30/71	12/12/79	1992	n/a
Metal weapons components	42,505	20,914	—[b]	—	—	—	1000	—	—	64,419
Depleted uranium scrap and shapes[c]	463	4063	8459	2675	27,015	3138	4838	—	—	50,651
Photographic film	4660	7665	9500	9330	—	—	—	—	—	31,155
Classified shapes[c]	1875	—	12,119	19,455	13,822	28,790	32,038	34,205	21,570	16,3874
Firing assemblies	1000	—	—	—	—	—	—	2610	—	3610
Graphite components	1000	5179	—	—	—	400	—	—	—	6579
Tungsten carbide scrap	11,500	—	—	—	—	—	—	—	—	11,500
Drummed radioactive waste	728	—	—	—	—	—	—	—	—	728
Plastic parts (assorted)	—	4500	—	—	—	—	—	—	—	4500
Lithium fluoride PBX[b] (HE)	—	—	4408	—	—	—	—	—	—	4408
Metal containment for explosives	—	—	2500	—	—	—	—	—	—	2500
Serial-numbered items	—	—	1500	—	—	—	—	—	—	1500
Fuel elements	—	—	255	1645	2365	2725	—	—	—	6990
Tritium classified unit	—	—	—	35	—	—	—	—	—	35
Lithium shapes	—	—	—	400	—	—	—	60	—	460
Plutonium-contaminated shapes[d]	—	—	—	—	—	—	275	—	—	275
Lead coil assemblies	—	—	—	—	—	—	2150	—	—	2150
Electronic data tapes	—	—	—	—	—	—	—	1360	1300	2660
Tracer cans and templates	—	—	—	—	—	—	—	430	—	430
Decontamination and decommissioning scrap	—	—	—	—	—	—	—	20,500	—	20,500
Files and file storage	—	—	—	—	—	—	—	—	925	925
Computer disks	—	—	—	—	—	—	—	—	1487	1487
Motor oil w/graphite	—	—	—	—	—	—	—	—	40	40
Shaft Total	**63,731**	**42,321**	**38,741**	**33,540**	**43,202**	**35,053**	**40,301**	**59,165**	**25,322**	**381,376**

Note: Weight of material disposed of is in pounds.

[a] n/a = not applicable.

[b] A dash indicates that wastes of this type were not disposed of in that shaft.

[c] PBX = plastic-bonded explosives.

[d] The term *shape* refers to various shaped, typically inert, preliminary design mockups of explosive devices.

Inventory of Materials at MDA H

Disposal of waste materials at MDA H was restricted to items or materials that authorized personnel determined to be both classified and either excess or no longer required. This determination was recorded on special forms that accompanied the waste to MDA H. Procedures required that two people observe and sign off on the disposal activities (Myers 2001, 70028). Disposals were recorded in a logbook (LASL 1960, 70034) that contains descriptions of the items or materials disposed of, an approximate mass (weight), a cross-reference to the detailed waste disposal form (Disposal of Contaminated and/or Classified Property form (252-R), and signatures of the witnesses. All material disposed of at MDA H required either double packaging with an opaque outer material, such as plastic bags or drums, or special security approvals for materials that, because of physical size, precluded the standard packaging. Light-weight wastes were dropped into the shafts, while heavier materials were lowered in by heavy equipment. Based on information in early records, the density of the waste materials varied from as low as 5 lb per cubic foot up to 540 lb per cubic foot.

RCRA-regulated hazardous waste chemicals known to be in the MDA H inventory include several reactive lithium compounds (including lithium fluoride, lithium hydride, and lithium boride) and HE. Additional potentially regulated RCRA hazardous wastes are anticipated because they (lead, silver, barium, and cadmium) were used for shielding, solders, parts, and coatings. Other hazardous constituents, such as beryllium, are known to be in the inventory. The radionuclides known to be in the inventory include tritium, uranium-235, and uranium-238. While logbook descriptions (LASL 1960, 70034) include sufficient information to identify, with some degree of certainty, the hazardous wastes and radionuclides in the inventory, the amounts of these materials cannot be absolutely quantified (because of impracticability and national security). Therefore, records, process knowledge of former site operations, and best professional and engineering judgment were applied to estimate the quantity of these materials. The current results are summarized in the following paragraphs and in Table 2.2-2. It is important to understand, however, that corrective action decisions must be and can be made in the face of uncertainties in the amount of certain constituents in the inventory.

Lithium Compounds. Lithium hydride reacts with water, either liquid or vapor, to form lithium hydroxide and hydrogen. For lithium hydride solids in the MDA H inventory (such as *shapes*), this reaction is expected to form a hydroxide coating on the exposed surface that inhibits the reaction beneath the surface. It is assumed that reactive (still hazardous) lithium hydride remains in the inventory. The same situation exists for any lithium hydride that was contained within a vessel in the inventory. Only lithium hydride powders exposed to moisture would be expected to be fully reacted (nonhazardous) now. This assumption is also applied to the lithium fluoride and lithium boride in the inventory assuming that, for modeling purposes, both are as reactive as lithium hydride and would result in an explosion on contact with water or toxic salt.

High Explosives. The largest mass of potential HE is lithium fluoride PBX. Additional review of documentation is being conducted to estimate the actual quantity of material. Based on procedures for handling HE for disposal, the HE-contaminated waste is likely to be contaminated with PBX. It is assumed that all HE-contaminated materials were contaminated with 1,3,5-trinitro-1,3,5-triazacyclohexane (RDX), unless PBX is specified. This assumption is conservative, based on the relative mobility, persistence, and toxicity of RDX compared with other conventional HE. The masses indicated in the logbook (LASL 1960, 70034) are masses of the contaminated structures and not masses of HE. Discussions with subject matter experts indicate that residual contamination on the waste structures disposed of at MDA H would be indiscernible or else the items would have (by procedure) been flashed at Laboratory burning grounds before being disposed of at MDA H. Therefore, gross upper-bound values have been estimated and are conservative.

Table 2.2-2
Estimated Amounts of Constituents in the Inventory at MDA H

Inventory Constituent	Estimated Amount	Assumptions/Comments
Beryllium	238 lb	Solid form
Lithium Lithium hydride Lithium fluoride Lithium boride	 526 lb <4400 lb 10 lb	Majority in solid form, not oxidized and therefore still reactive
HE PBX RDX	51,958 lb total gross weight of items with residual HE contamination <4400 lb <100 lb	Unless otherwise specified, HE is assumed to be RDX, based on mobility and toxicity. Unless otherwise specified, assume indiscernible surface contamination.
Film (silver)	42,296 lb total gross weight of film	Component of photographic film, therefore not leachable
Pthalates/plastics	6545 lb total gross weight	Present in packaging and plastic explosives
Fuel elements Uranium-235 Uranium-238	 <13.6 Ci <0.57 Ci	Standard ratios apply for converting depleted uranium and fuel (enriched uranium) masses to isotopic abundances.
Uranium Uranium-234 Uranium-235 Uranium-238	 26 Ci 0.6 Ci 35 Ci	Standard ratios apply for converting depleted uranium and fuel (enriched uranium) masses to isotopic abundances.
Tritium	240 Ci	Residual radioactivity in stainless steel canisters of known mass; estimate based on average MDA G high-activity tritium waste concentration (this is a very conservative basis for this estimate)
Plutonium Plutonium-238 Plutonium-239 Plutonium-240 Plutonium-241 Plutonium-242	27 mCi (isotopic) 25 mCi 0.0027 mCi 1.6 mCi 0.054 mCi 0.054 mCi	Assume 100 nCi/g as limit of detection Assume plutonium-52 as isotopic composition, based on most common waste contamination

Beryllium. The MDA H logbook (LASL 1960, 70034) indicates that just over 240 lb of beryllium was disposed of. Based on the descriptions, it is assumed that this mass is in the form of solid metal.

Tritium. There are several considerations that are important when converting logbook descriptions into a quantity of tritium. First, tritium was used primarily as a gas or vapor in classified applications. Second, tritium is an accountable material and therefore would have been recovered when possible and would only have been disposed of in relatively small (unaccountable) quantities. Third, liquid tritium waste was not disposed of at MDA H but was typically absorbed onto a solid matrix and disposed of MDA G. (Myers 2001, 70029). This information was used to estimate the amount of tritium associated with items disposed of at MDA H; the items had a total mass of 2400 lb.

Plutonium. The majority of the radioactive waste generated at the Laboratory (even classified) was disposed of at MDA G and not MDA H. Plutonium is present only as residual contamination on classified

shapes and other items, and the amount of plutonium is assumed to be below the detection limits (DLs) of instruments used when the waste was placed at MDA H. Established guidelines dictated that materials containing plutonium above a certain level of contamination were sent for recovery of plutonium and not for disposal and therefore are not in the MDA H inventory.

Uranium. Two general descriptions of uranium waste are found in the MDA H logbook (LASL 1960, 70034). One is of depleted uranium, and the other is of fuel elements or pellets. The documented mass of these categories of waste was converted directly into amounts of uranium-238 and uranium-235 (the longest-lived isotopes) using standard ratios nationally recognized by actinide scientists as representative of uranium-related activities. The documented mass of depleted uranium in MDA H is 21,528 lb. It was assumed that 80% of the mass associated with "shapes, molds, modules, mockups and scrap," with no additional material specification in the logbook (LASL 1960, 70034), was also depleted uranium. The documented mass of fuel elements or pellets is 17,645 lb.

On a mass basis, the major contributor (about 60%) to the MDA H inventory is metal, of which most is either indicated as or assumed to be depleted uranium, based on process knowledge and interpretation of logbook entries (LASL 1960, 70034). Reactive materials, such as lithium compounds and HE, represent approximately 1% and 13%, respectively. Approximately 12% of the mass is recording media (paper documents, film (developed), slides, magnetic computer tapes). Graphite represents about 12% of the mass inventory, and *unreacted fuel* (consisting of various isotopes of uranium) accounts for approximately 5% of the inventory. Additional materials disposed of include plastics accounting for approximately 1.7% of the inventory.

2.3 Investigation Activities

2.3.1 Previous Field Investigations

Before the RFI, other Laboratory groups conducted several investigations at MDA H. The investigations described in this section were used to support the development of the preliminary site conceptual model of potential contaminant release, transport, and fate.

2.3.1.1 Tritium Measurements

In 1969, subsurface samples were collected as part of a Laboratory-wide effort to determine background for tritium in tuff. A single soil-moisture core sample and several air samples were collected at a depth of 40 ft inside shaft 8; several air samples were also collected at the same depth in shaft 7. Pore water in the core sample had an activity-based tritium concentration of approximately 2.0×10^9 pCi/L, and the air samples had an average concentration of 4.4×10^8 pCi/L (Aeby 1969, 1799). To determine the extent of tritium at MDA H, the investigation was expanded to include sampling and analysis of air and soil in and around the nine disposal shafts. Fourteen soil samples and four air samples were analyzed; the highest concentrations were measured in samples from around shaft 8. Table 2.3-1 lists the tritium analytical results for the 1969 sampling.

In 1973, additional soil and flora samples from MDA H were analyzed for tritium (LANL 1992, 7669). Plants growing in the area were found to have concentrations of tritium three orders of magnitude higher than species in other uncontaminated areas. Surface soils near the shafts had measured concentrations of tritium about two to three times the concentration measured in background samples outside of the area. These data were used to support the conceptual model for fate and transport of tritium at MDA H. Table 2.3-2 lists the analytical results for the 1973 sampling.

Table 2.3-1
1969 Tritium Sampling Results for MDA H

Sample Number	Counts*	Activity (pCi/L)
1 (soil)	4.6×10^{6}	2.1×10^{9}
4 (soil)	9.9×10^{3}	4.5×10^{6}
8 (air)	9.3×10^{5}	4.2×10^{8}
9 (air)	1.0×10^{6}	4.6×10^{8}
10 (air)	9.8×10^{5}	4.5×10^{5}
11 (air)	3.5×10^{5}	1.6×10^{8}
12 (soil)	2.0×10^{3}	9.1×10^{5}
13 (soil)	5.1×10^{1}	2.3×10^{4}
18 (soil)	1.4×10^{2}	6.6×10^{4}
19 (soil)	1.4×10^{2}	6.5×10^{4}
20 (soil)	5.3×10^{2}	2.4×10^{5}
21 (soil)	2.5×10^{2}	1.1×10^{5}
22 (soil)	2.5×10^{3}	1.1×10^{6}
23 (soil)	7.3×10^{1}	3.3×10^{4}
24 (soil)	2.8×10^{2}	1.3×10^{5}
25 (soil)	6.8×10^{3}	3.1×10^{6}
26 (soil)	3.8×10^{2}	1.7×10^{5}
27 (soil)	1.3×10^{2}	6.0×10^{4}

* Counts were taken in 1969 and are in units of disintegrations per minute per milliliter.

Table 2.3-2
1973 Tritium Soil and Flora Sampling Results for MDA H

Samples	Activity (pCi/L)
Soil at fence	7.79×10^{4}
Soil 20 ft south of fence	7.38×10^{4}
Soil 75 ft south of fence	3.08×10^{4}
Soil 150 ft south of fence	3.40×10^{3}
Background soil	2.40×10^{4}
Mountain daisy near shaft 8	3.41×10^{6}
Weed near shaft 8	2.79×10^{6}
Piñon 60 ft east of southwest corner of fence	6.10×10^{3}
Cedar 60 ft east of southwest corner of fence	2.18×10^{6}
Cedar 65 ft west of southeast corner of fence	1.40×10^{6}
Piñon background	2.40×10^{3}
Cedar background	2.30×10^{3}
Background weeds	2.00×10^{3}
Background mountain daisy	2.10×10^{3}

2.3.1.2 VOC Flux Measurements

Five measurements of surface VOC flux were collected in 1994 by the Laboratory Waste Management Program (Trujillo et al. 1998, 58242). The samples were obtained using passive diffusion cartridges placed under cups on the ground surface for a 72-hr period. Analysis of the cartridges was conducted using EPA Method 8240 (LANL 1991, 27915). Details of the investigation are reported in a Quadrel Services report (Quadrel 1994, 63869) and Trujillo et al. (1998, 58242).

2.3.2 Preliminary Conceptual Model

The preliminary site conceptual model, shown in Figure 2.3-1, illustrates the potential sources of contamination at MDA H, potential source release mechanisms, and potential transport pathways that may result in on-site and off-site redistribution of contaminants.

The figure illustrates the following information.

- Mesa-Canyon Topography. The topography has important effects on air, surface water, and subsurface contaminant transport, as well as on potential receptors.
- Geology. The figure illustrates subsurface layers of various volcanic depositions (e.g., units of the Tshirege Member of the Bandelier Tuff, the Otowi Member of the Bandelier Tuff, and the Cerros del Rio basalts). The geology has variable physical and chemical features that dramatically affect subsurface contaminant transport.
- Hydrology. The hydrology affects surface and subsurface transport of contaminants and includes intermittent surface streams in adjacent canyons as well as liquid- and vapor-phase water moving through the subsurface within the rock matrix, within fractures in the rock, along interfaces between layers, and upward from the site because of transpiration.

The solid arrows represent the movement of water as a liquid (straight arrows) and as a vapor (serpentine arrows). Liquid water generally infiltrates down into the mesa, and water vapor generally moves upward, undergoing evapotranspiration along the top and sides of the mesa.

Contamination may exist at residual levels in the surface soils and underlying tuff or be released from the disposed waste. Source release mechanisms for the buried waste are illustrated in the conceptual model with straight and serpentine arrows around the shafts. The straight arrows represent movement of leachate percolating through the shafts. The serpentine arrows suggest releases of contamination into the air, either as gases or as dust particles. The actual source term for resuspended particulates involves processes that may lead to surface contamination, including intrusion into the disposed waste by plants, animals, and erosion.

Contaminants potentially present on the surface of the site or released from the disposed waste may be transported away from the site through a variety of transport pathways. Contaminant transport pathways are identified in Figure 2.3-1 by open arrows; important pathways include

- subsurface transport of leachate through the geologic strata beneath the shafts toward the regional aquifer,
- atmospheric transport of gases and suspended particulates to downwind locations,
- surface water transport of contaminants deposited on the mesa top by plants and animals or exposed by cover erosion or cliff retreat, and
- subsurface migration of vapor-phase tritium contaminants in pore gas.

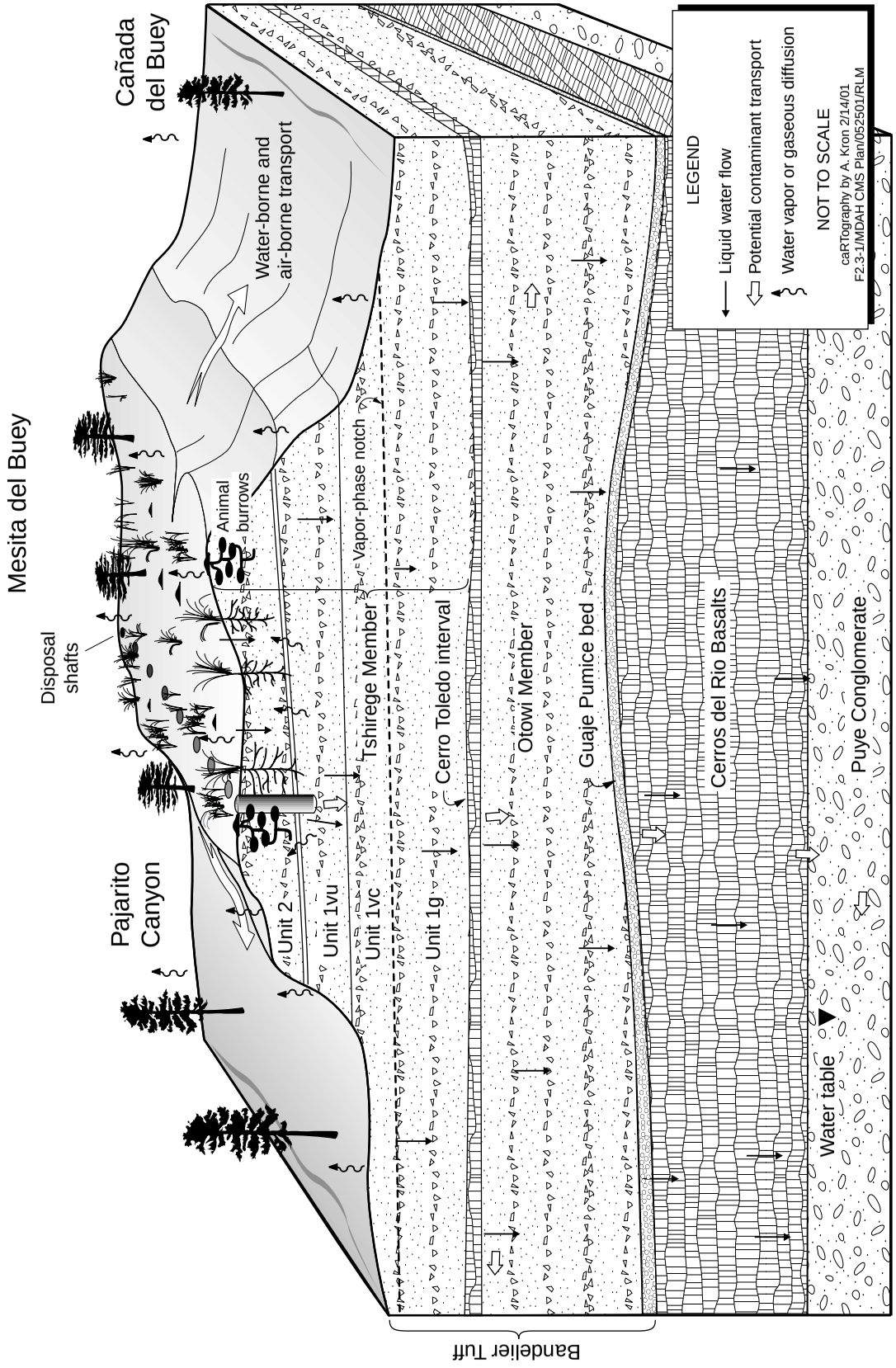

Figure 2.3-1. Site conceptual model for MDA H

Potential surface contamination at the site and contaminant releases from the buried waste may result in exposures to on-site human and ecological receptors through a variety of pathways. Present-day exposures to humans are relatively limited because of the restrictions placed on site access and the subsurface disposition of the wastes.

2.3.3 RFI Fieldwork

The ER Project conducted RFI fieldwork at MDA H from 1994 to 1995 and in Spring 2001. The RFI work plan specified sampling of surface water, surface sediment, and tuff and analyzing samples for inorganic chemicals (target analyte list [TAL] metals plus cyanide), organic chemicals (VOCs, semivolatile organic compounds [SVOCs], pesticides, and polychlorinated biphenyls [PCBs]), and radionuclides (LANL 1992, 7669). The objectives of the work plan were to determine if contaminants had been released from MDA H, to define the nature and extent of any contaminant releases, to collect data to support and supplement existing data, and to collect data to be used in a risk assessment. The RFI fieldwork at MDA H included

- drilling four vertical boreholes around the nine disposal shafts,
- collecting and analyzing 33 core samples from the boreholes, and
- collecting and analyzing four sediment samples.

A summary of work plan specifications, fieldwork performed, and the rationales for deviations from the work plan are in Table 2.3-3. Surface water runoff samples were not collected at MDA H but were collected at MDA G. These data were used in a qualitative manner to develop the site conceptual model for all MDAs at TA-54, including MDA H.

2.3.3.1 Channel Sediments

Runoff from MDA H is concentrated into a single drainage that carries surface runoff into Pajarito Canyon to the south (Figure 2.3-2). The drainage traverses the south side of Mesita del Buey from the southeast corner of the MDA H fence, drops over the cut of an abandoned road near Pajarito Road, eventually crosses the abandoned road, and flows into a tributary of Pajarito Canyon near TA-18. In 1994, eight sites were selected for sediment sampling to determine if contaminants had migrated from MDA H; the most likely depositional areas (e.g., low areas, behind obstructions) for the channel were determined by an on-site geomorphic survey. These sites included areas with coarse sediment deposition on the upper slope and areas with finer sediment deposition on the lower slope. Eight sediment samples (and two duplicate field samples) were collected and field screened for alpha, beta, and gamma radiation to bias sample selection. The sample with the highest gross gamma activity and three other samples selected at random were submitted to an off-site contract laboratory to be analyzed for inorganic chemicals, cyanides, PCBs, pesticides, tritium, and radionuclides (Environmental Restoration Project 1996, 54462).

2.3.3.2 Core Sampling

From June 23, 1995, to February 12, 1996, four boreholes were drilled as part of the MDA H RFI fieldwork. Detailed borehole logs, including lithologies and well construction diagrams, are presented in Appendix H. The locations of the boreholes and their relation to the shafts are shown on Figure 2.2-1. Pertinent information on each borehole is shown in Table 2.3-4. From continuous core drilled in each borehole, 33 samples were collected (see Appendix D for depth intervals). The samples collected were submitted to an off-site contract laboratory for analysis of TAL metals, cyanide, VOCs, SVOCs, PCBs, pesticides, tritium, and radionuclides.

Table 2.3-3
Summary of Work Plan Specifications, Fieldwork, and Rationales for Deviations

Media	Work Plan Specification		Actual Fieldwork Performed		Rationale for Deviation
	Number Samples Analyzed	Analytes (Method)	Number Samples Analyzed	Analytes (Method)	
Surface water runoff	1	VOCs, SVOCs, inorganic chemicals, pesticides, PCBs, cyanide, radionuclides, tritium	0	n/a*	ESH-18 (Water Quality and Hydrology Group) and ESH-19 (Hazardous and Solid Waste Group) data from MDA G were used to support site conceptual model development (Jansen and Taylor 1996, 54959).
Sediment (drainages)	9	VOCs, SVOCs, inorganic chemicals, cyanide, pesticides, PCBs, radionuclides, tritium	8/4	Inorganic chemicals, cyanide, pesticides, PCBs, radionuclides, tritium	Eight samples were collected based on a geomorphic survey. All samples were field screened for alpha, beta, and gamma radiation to bias sample selection. One sample with the highest gross gamma level and three other samples were sent to a contract laboratory for analysis (Glatzmaier 1994, 52015).
Pore gas	24 (4 open boreholes)	VOCs (SUMMA/SW 846)	3	VOCs (EPA Method TO-14)	In March 2001, pore gas in borehole 54-1023 was screened for VOCs using a Bruel and Kjaer analyzer every 20 ft from 25 ft to 245 ft. Pore-gas samples were then collected at 60 ft in SUMMA canisters.
	0	Tritium	8	Tritium	In March 2001, pore-gas samples were collected in borehole 54-1023.
Core	24 (4 boreholes)	VOCs, SVOCs, inorganic chemicals, pesticides, PCBs, cyanide, radionuclides	33	Inorganic chemicals, cyanide, PCBs, pesticides, VOCs, SVOCs, radionuclides, tritium	More samples were collected than specified in the work plan.

* n/a = not applicable.

2.3.4 Data Review

The RFI data set for MDA H includes analytical data from 4 sediment samples from the drainage channel and 33 tuff samples collected from the boreholes; Figure 2.2-1 shows the sample locations. All data used quantitatively to identify COPCs at MDA H were subjected to ER Project QA/ QC. An overview of the QA/QC findings is included here for each class of chemical and medium sampled, and the results of a detailed review of QA/QC activities are provided in Appendix C.

The data review process for identifying COPCs begins with a comparison of site data with

- naturally occurring background concentrations for inorganic chemicals,
- naturally occurring background or fallout concentrations for radionuclides, and
- analytical EQLs for organic chemicals.

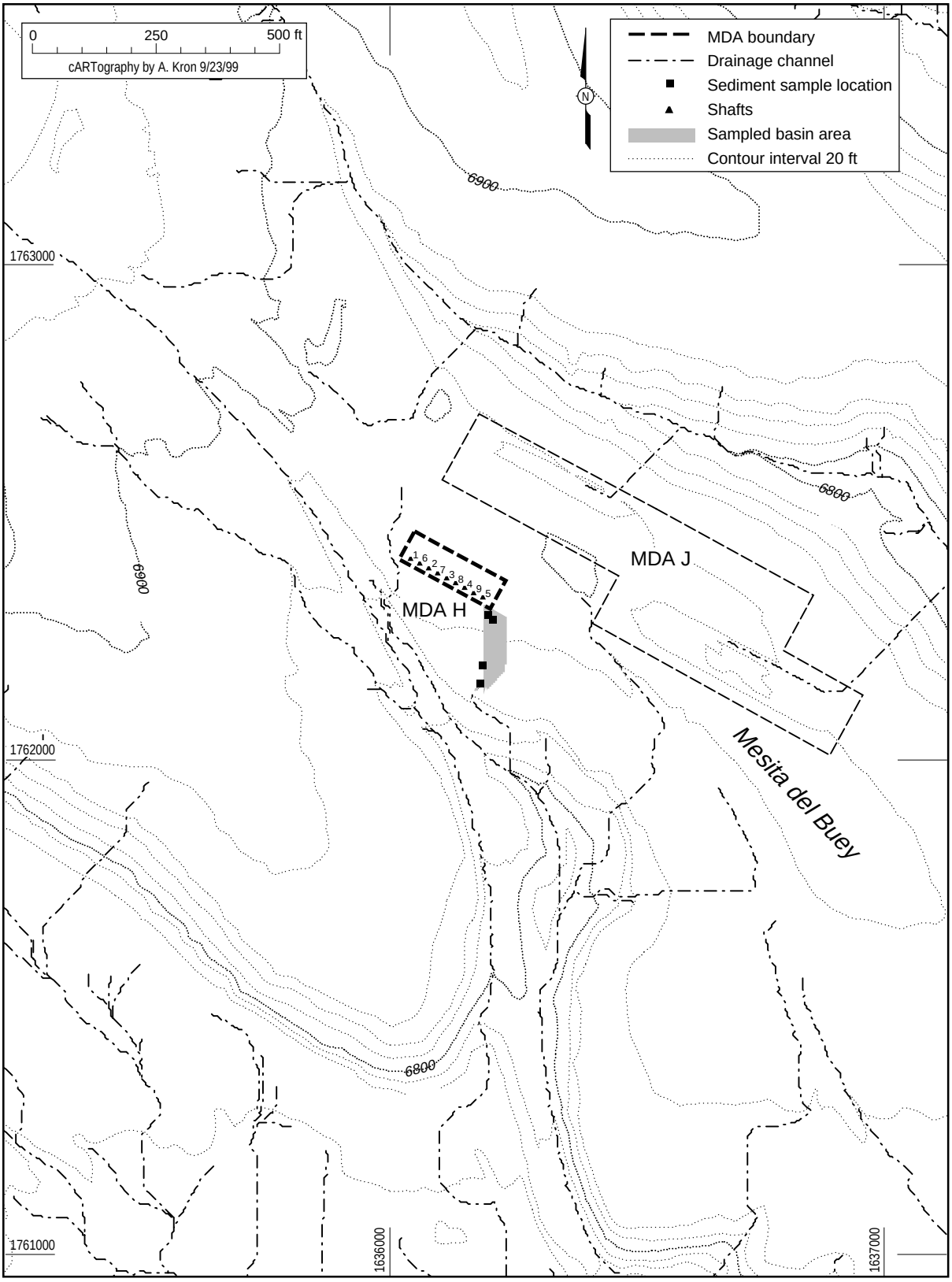

Figure 2.3-2. MDA H drainage

Table 2.3-4
Summary Information of RFI Boreholes at MDA H

Borehole ID	Declination (degrees)	Surface Elevation (ft)[a]	Borehole Length (ft)	Vertical Depth (ft)	Total Depth Elevation (ft)	Total Depth Formation	NAD 83[b] Northing	NAD 83 Easting	Drilling Dates	Borehole Completion
54-1023	90	6884	259.7	259.7	6624.3	Qct	1,762,333.44	1,636,125.65	6/23/95–2/12/96	Open hole with surface casing
54-1024	90	6885	90	90	6795	Qbt 1v(u)	1,762,323.99	1,636,195.54	6/29–7/5/95	Backfilled
54-1025	90	6887	90	90	6797	Qbt 1v(u)	1,762,390.86	1,636,083.80	7/6/95	Backfilled
54-1026	90	6887	90.5	90.5	6796.5	Qbt 1v(u)	1,762,416.64	1,636,016.79	6/26–29/95	Backfilled

[a] Elevations are feet above the mean sea level.

[b] NAD 83 indicates North American datum 1983.

Background comparisons and a variety of statistical and graphical methods are used to compare site inorganic and radionuclide data with Laboratory background data. Organic chemical data are evaluated for detection status only. For background comparisons, the first step is to compare the site data with a BV, which is an estimated value for the background data set (upper tolerance limit [95, 95] or the 95% upper confidence bound on the 95th quantile). If a site-specific datum exceed its BV, additional evaluation of the datum may be performed by comparing the range of values in the site data set for that chemical to the range of values for that chemical in the background data set. Graphical analyses (e.g., box plots) may be used, or if adequate data are available, statistical tests that evaluate differences in distribution may be utilized. Nonparametric tests commonly used to assess data distributions include the Gehan, quantile, and slippage tests. Together these tests assess complete shifts in distributions, shifts of a subset of the data, and the potential for some of the site data to be greater than the maximum BV. Observed significance levels (p-values) are obtained, these values indicate whether a difference does or does not exist between the data sets. A p-value of less than 0.05 indicates that there is a difference between the distributions (i.e., the site data are different from the background data), while a p-value greater than 0.05 indicates that there is no difference between distributions (i.e., site and background data are similar). Statistical tests and results are discussed in Appendix E.

Graphical analyses of the data sets provide a visual representation of the data and allow a visual comparison among concentration distributions. The observed differences may include an overall shift in concentration or, when centers are nearly equal, a difference between the upper tails of the two distributions. The plots may either be used alone to describe the relationship of the two distributions or may be used in conjunction with the statistical tests described earlier. The graphical analyses used to assess the inorganic and radionuclide data from MDA H were box plots (Appendix E).

Only data that are relevant for identifying COPCs are included in this section; this includes measurements that are above applicable thresholds or whose DLs are greater than an applicable threshold. Tables D-2.0-1, D-2.0-2, D-2.0-3, D-2.0-4, D-2.0-5, and D-2.0-6 in Appendix D include the data for all analytes (detected and undetected).

2.3.4.1 Channel Sediment

Channel sediments at MDA H are derived from the mesa-top materials, the tuff on the sides of the mesa, and colluvium and soils on the mesa slopes (Environmental Restoration Project 1996, 54462). The samples were described in the field summary report as soil samples and in the channel sediment report as silt, sand, and gravel mixtures. Sample concentrations were compared with the Laboratory sediment background data set (Ryti et al. 1998, 59730) (Table 2.3-5), which was derived from sediment samples collected in Indio, Ancho, Los Alamos, Pueblo, and Guaje Canyons. These deposits are described in Ryti et al. (1998, 59730) as young alluvium in or near stream channels. Consequently, the Laboratory background data set for sediments might represent a different matrix than the channel sediment samples collected at MDA H.

Table 2.3-5
Frequency of Detected Inorganic Chemicals in Channel Sediment Samples

Analyte	Number of Detects	Concentration Range (mg/kg)[a]	Sediment BV (mg/kg)[b]	Frequency of Detects Above BV
Aluminum	4	1140–4800	15400	0/4
Antimony	0	[0.2]	0.83	0/4
Arsenic	0	[0.91–1.7]	3.98	0/4
Barium	3	[32.4]–71	127	0/4
Beryllium	0	[0.2–0.39]	1.31	0/4
Boron	0	[1.6]	No value	0/4
Cadmium	0	[0.26–0.68]	0.4	3/4 DL > BV
Calcium	2	[912]–1590	4420	0/4
Chromium	4	2.4–4.8	10.5	0/4
Cobalt	0	[1.7–4.6]	4.73	0/4
Copper	0	[2.1–4.1]	11.2	0/4
Cyanide	0	[0.2–0.28]	0.82	0/4
Iron	4	3690–5890	13800	0/4
Lead	4	13.1–21.3	19.7	2/4
Magnesium	0	[513–948]	2370	0/4
Manganese	4	116–300	543	0/4
Mercury	0	[0.02]	0.1	0/4
Molybdenum	0	[5.2–5.3]	No value	0/4
Nickel	0	[1.2–2.9]	9.38	0/4
Potassium	0	[195–723]	2690	0/4
Selenium	0	[0.6–0.61]	0.3	4/4 DL > BV
Silver	0	[0.6–0.61]	1.0	0/4
Sodium	0	[28.7–67.5]	1470	0/4
Thallium	0	[0.2]	0.73	0/4
Vanadium	1	[6.7]–11.2	19.7	0/4
Zinc	4	0.2–35.3	60.2	0/4

Note. Four samples were analyzed; all were analyzed for each chemical listed in the table.

[a] Values in square brackets indicate nondetects.

[b] Sediment BVs obtained from Ryti et al. (1998, 59730).

Inorganic Chemical Comparison with Background

Except for aluminum, there were no QA/QC issues associated with the inorganic chemical results at MDA H. Results for aluminum are qualified as J (estimated) because recovery in the QC sample was low. Overall, the sediment inorganic chemical data for MDA H are of good quality and suitable for data assessments. Table C-5.1-1 in Appendix C presents detailed results of the QA/QC assessment. Table D-2.0-1 in Appendix D provides the complete data set.

Lead was detected above the Laboratory-wide sediment BV of 19.7 mg/kg in two coarse sediment samples (locations 54-5130 and 54-5131) at concentrations of 21.3 mg/kg and 19.9 mg/kg, respectively. A box plot depicting the distributions of the background and site data sets shows that the two distributions are similar (2 mg/kg to 25.6 mg/kg versus 13.1 mg/kg to 21.3 mg/kg, respectively) (Appendix E, Figure E-3.1-1). Based on the sediment background comparison, lead is not identified as a COPC at MDA H.

Cadmium was not detected in the channel sediments, but DLs in three of four samples (0.41, 0.5, and 0.68 mg/kg) exceeded the sediment BV of 0.4 mg/kg as well as the range of values in the sediment background data set (0.05 mg/kg to 0.18 mg/kg). Based on this evaluation, cadmium is assumed to be different from background.

Selenium was also not detected in the channel sediments, but DLs (0.6 to 0.61 mg/kg) exceeded its BV of 0.3 mg/kg. No selenium was detected in the sediment background samples, and the DL was 0.1 mg/kg. Based on this evaluation, selenium is assumed to be different from background.

Lead was detected at concentrations above the Laboratory-wide sediment background level but within the range of concentrations in the background data set. Cadmium and selenium, while not detected, had DLs elevated above Laboratory-wide sediment background levels. All other inorganic chemicals were not different from sediment background concentrations at MDA H. Table E-3.1-1 and Figure E-3.1-1 in Appendix E provide more details on the inorganic statistical tests.

Radionuclide Comparison with Background and Fallout Values

Except for tritium, there were no QA/QC issues associated with the radionuclide results for samples collected at MDA H. Three tritium results were qualified as J (estimated) because the blind QC sample recovery was outside the QC sample acceptance limits. Overall, the sediment radionuclide data for MDA H are of good quality and suitable for data assessments. Table C-5.3-1 in Appendix C presents detailed results of the QA/QC assessment. Table D-2.0-3 in Appendix D provides the complete data set.

Detected concentrations of radionuclides were compared with either the sediment BV or the sediment fallout value (Ryti et al.1998, 59730), depending on whether the radionuclide is naturally occurring or a fallout radionuclide. Americium-241, cesium-137, cobalt-60, tritium, plutonium-238, plutonium-239, and strontium-90 were compared with sediment fallout values. Isotopes of uranium and thorium, which are naturally occurring radionuclides, were compared with sediment BVs (Table 2.3-6).

The channel sediment report (Environmental Restoration Project 1996, 54462) listed americium-241, polonium-210, and yttrium-90 as COPCs because no background and fallout values for those radionuclides were available at that time. Currently, americium-241 has a sediment fallout value of 0.04 pCi/g, which is greater than the detected concentrations in the channel sediment (Table 2.3-6). Polonium-210 and yttrium-90 both have short half-lives (approximately 138 days and 60 hours, respectively), so they are no longer present in the channel sediment and are, therefore, not evaluated in this RFI report.

Table 2.3-6
Frequency of Detected Radionuclides in Channel Sediment Samples

Analyte	Number of Detects	Concentration Range (pCi/g)a	Sediment Background or Fallout Value (pCi/g)b	Frequency of Detects or Detects Above Background or Fallout Value
Americium-241	2	[0.003]–0.008	0.04	0/4
Cesium-137	2	[0.08]–0.48	0.9	0/4
Cobalt-60	0	[0.04–0.07]	No value	0/4
Plutonium-238	0	[0.001–0.003]	0.006	0/4
Plutonium-239	1	[0.001]–0.017	0.068	0/4
Radium-226	1	[0.25]–1.2	2.59	0/4
Strontium-90	0	[–0.02–0.14]	1.04	0/4
Technetium-99	0	[0.2]	No value	0/4
Thorium-228	4	0.84–1.22	2.28	0/4
Thorium-230	4	0.76–1.21	2.29	0/4
Thorium-232	4	0.87–1.3	2.33	0/4
Tritium	4	0.004–0.11	0.093	1/4
Uranium-234	4	0.71–1.34	2.59	0/4
Uranium-235	0	[0.05–0.08]	0.2	0/4
Uranium-238	4	0.77–1.36	2.29	0/4

NOTE. Four samples were analyzed; all were analyzed for each chemical listed in the table.
[a]Values in square brackets indicate nondetects.
[b]Sediment background and fallout values obtained from Ryti et al. (1998, 59730).

The detected activity concentration for tritium in one sample (0.111 pCi/g) exceeded the associated sediment fallout value of 0.093 pCi/g (Figure 2.3-3). The highest detected concentration was also above the maximum concentration in the tritium fallout data set. No other radionuclides were detected above their respective background or fallout values; Table E-3.1-2 in Appendix E presents more details on the radionuclide background comparisons. Tritium is, therefore, retained as a COPC in channel sediments at MDA H.

Evaluation of Organic Chemicals

The four sediment samples were analyzed only for PCBs and pesticides. There were no QA/QC issues associated with the analytical data, and the data are of sufficient quality to identify COPCs. Table C-5.2-1 in Appendix C presents the detailed results of the QA/QC assessment. Table D-2.0-2 in Appendix D provides the complete data set.

Methoxychlor was detected in two samples at concentrations of 0.036 mg/kg (location 54-5130) and 0.04 mg/kg (location 54-5132), which are approximately twice the EQL (0.02 mg/kg) (Figure 2.3-4). No other organic chemicals were detected in the sediment samples; Table E-3.1-3 in Appendix E provides more details on the organic chemical analyses. Methoxychlor was retained as a COPC in channel sediments at MDA H.

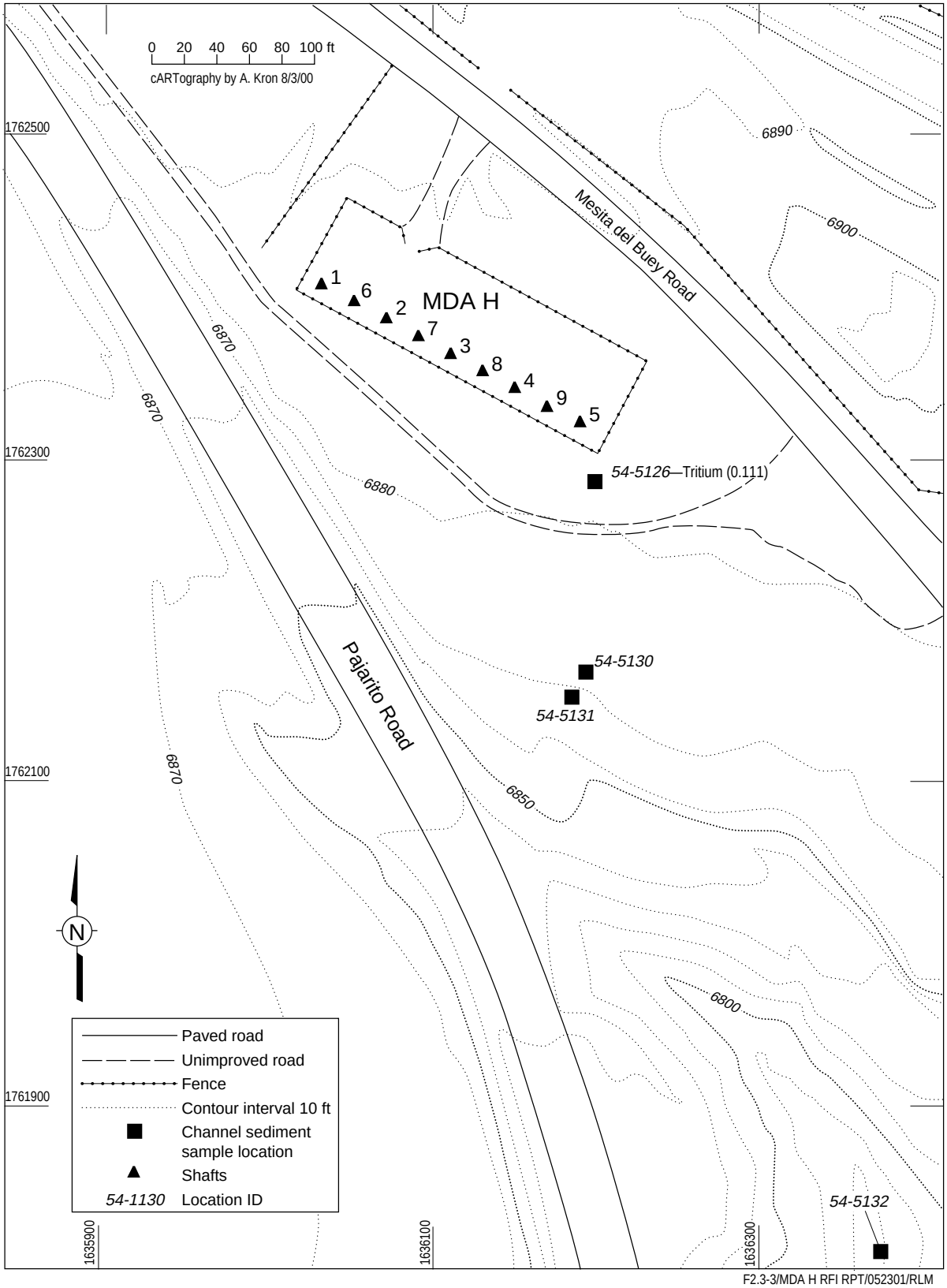

Figure 2.3-3. Detections of tritium (pCi/g) above fallout levels in channel sediment samples at MDA H

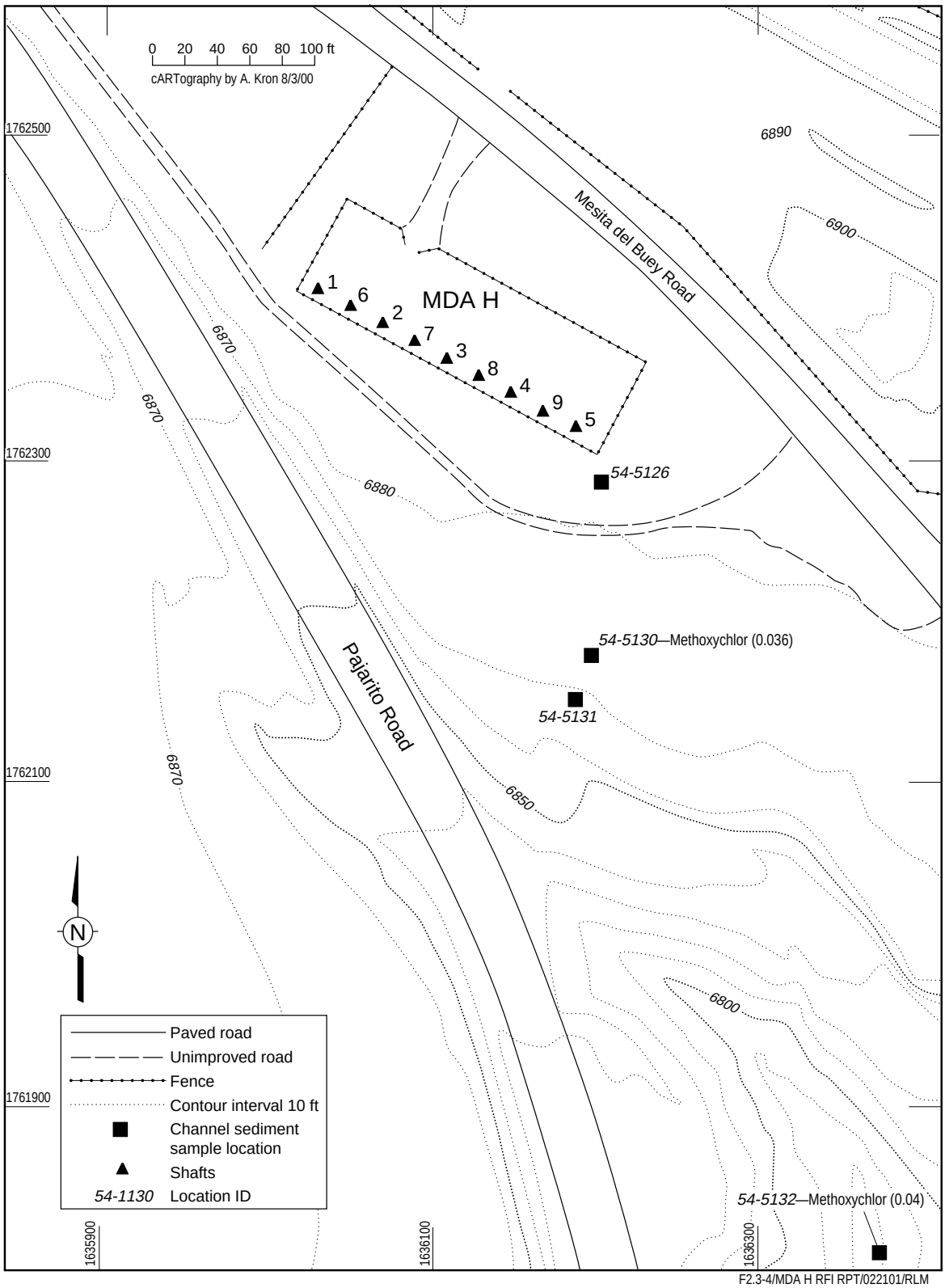

Figure 2.3-4. Detected concentrations (mg/kg) of methoxychlor in channel sediment samples at MDA H

2.3.4.2 Subsurface Tuff Samples from Boreholes

Thirty-three tuff samples were collected from four vertical boreholes. Thirteen were collected from Qbt 2 of the Tshirege Member of Bandelier Tuff, and 20 were collected from the deeper Qbt 1v. A field duplicate was collected for QA/QC purposes only and was not used as an additional data point in the data review process.

Boreholes 54-1024, 54-1025, and 54-1026 were each drilled to a depth of 90 ft. Borehole 54-1023 was drilled to a depth of 259.7 ft, but samples were not collected below 90 ft. Stratigraphic thicknesses obtained from the borehole logs indicate that Qbt 2 is approximately 30 ft thick, Qbt 1v is approximately 110 ft thick, and the Tsankawi Pumice Bed is approximately 1 ft thick beneath MDA H.

Inorganic Chemical Comparison with Background

Some data for antimony, manganese, and selenium are qualified as UJ or J because matrix spike recoveries were below recovery limits. Some lead data are qualified as J+ because matrix spike recoveries were above the recovery limits. Some data for antimony, arsenic, barium, beryllium, cadmium, calcium, chromium, cobalt, copper, magnesium, mercury, nickel, potassium, selenium, silver, sodium, thallium, and vanadium are qualified J because results were below the estimated DL but above the instrument DL. These data are usable and are potentially biased low or high; however, there is a higher analytical uncertainty than normally associated with inorganic chemical data. Copper and thallium in one sample each are qualified not detected (U) because the results are less than five times the result for these analytes in the preparation blank. Seven cyanide results from one borehole (54-1023) were qualified as R (unusable) because the matrix spike recoveries were less than 30%, making the level of confidence in the results too low. These data were not used in the subsequent assessments of the subsurface inorganic chemical data. Overall, the data are of good quality and suitable for data assessments. Data qualifiers are defined in Appendix A and Table C-5.0-1 in Appendix C. Table C-5.1-1 in Appendix C provides a comprehensive review of data quality.

Analytical results for the samples collected from Qbt 2 were compared with BVs for Qbt 2, 3, and 4, and samples from Qbt 1v were compared with BVs for that unit (Ryti et al.1998, 59730). Table 2.3-7 provides a summary of the analyses. Analytical results were plotted by depth in each borehole to identify patterns that might be associated with a release and migration through a fractured medium (Appendix E, Figures E-3.2-1 and E-3.2-2. Table D-2.0-4 in Appendix D provides the complete data set.

In all four boreholes, concentrations of copper at the uppermost sampling depth (approximately 9 ft below ground surface) were greater than three times the BV. However, concentrations of copper in all deeper samples were below the Qbt 1v BV. Statistical tests showed that copper concentrations are different from Qbt 2 background concentrations ($p<0.05$) but are not different from Qbt 1v background concentrations ($p>0.05$) (Appendix E). Copper is retained as a COPC; and concentrations greater than background are presented in Figure 2.3-5.

Chromium and thallium were detected at concentrations above their respective BVs in a single core sample; lead was detected at concentrations above its BVs in one sample from each of the two tuff units. Chromium and lead concentrations were not different from either tuff unit's background concentration (Qbt 2 and/or Qbt 1v) ($p>0.05$). Thallium was detected once in Qbt 2 core samples at a concentration (1.7 mg/kg) larger than the BV (1.1 mg/kg) but within the range of detected concentrations in Laboratory tuff background (0.05 mg/kg to 1.7 mg/kg). All the thallium DLs at MDA H were below the BV, but four of them were larger than the DLs observed in the Laboratory background samples. If these four larger DLs are treated as detects, then thallium concentrations at MDA H are not significantly different from background.

Table 2.3-7
Frequency of Detected Inorganic Chemicals in Tuff Samples

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (mg/kg)[a]	BV (mg/kg)[b]	Frequency of Detects Above BV
Aluminum	Qbt 2	13	13	187–3140	7340	0/13
	Qbt 1v	20	20	167–2570	8170	0/20
Antimony	Qbt 2	13	2	[0.1]–[4.9]	0.5	1/13 2/13 DLs > BV
	Qbt 1v	20	0	[0.1]–[5.0]	0.5	4/20 DLs > BV
Arsenic	Qbt 2	13	4	[0.2]–2.1	2.79	0/13
	Qbt 1v	20	8	[0.2]–1.8	1.81	0/20
Barium	Qbt 2	13	13	2.8–18	46	0/13
	Qbt 1v	20	20	1.7–10.7	26.5	0/20
Beryllium	Qbt 2	13	9	[0.08]–[0.49]	1.21	0/13
	Qbt 1v	20	16	0.1–[0.5]	1.7	0/20
Cadmium	Qbt 2	13	1	[0.02]–[0.49]	1.73	0/13
	Qbt 1v	20	2	[0.02]–0.52	0.4	1/20 4/20 DLs > BV
Calcium	Qbt 2	13	13	155–776	2200	0/13
	Qbt 1v	20	20	202–754	3700	0/20
Chromium	Qbt 2	13	9	[0.3]–7.0	7.14	0/13
	Qbt 1v	20	12	[0.3]–3.0	2.24	1/20
Cobalt	Qbt 2	13	8	0.14–1.8	3.14	0/13
	Qbt 1v	20	5	0.14–[1.01]	1.78	0/20
Copper	Qbt 2	13	9	[0.5]–35.4	4.66	4/13
	Qbt 1v	20	15	0.37–1.7	3.26	0/20
Cyanide	Qbt 2	11	0	[0.15–1.01]	0.5	2/11 DLs > BV
	Qbt 1v	15	0	[0.15–1.02]	0.5	4/15 DLs > BV
Iron	Qbt 2	13	13	685–4650	14500	0/13
	Qbt 1v	20	20	250–5330	9900	0/20
Lead	Qbt 2	13	13	1.3–16.2	11.2	1/13
	Qbt 1v	20	20	1.02–27.2	18.4	1/20
Magnesium	Qbt 2	13	13	27.8–400	1690	0/13
	Qbt 1v	20	20	27.6–321	780	0/20
Manganese	Qbt 2	13	13	49.6–212	482	0/13
	Qbt 1v	20	20	44.8–238	408	0/20
Mercury	Qbt 2	13	0	[0.02–0.1]	0.1	0/13
	Qbt 1v	20	3	[0.02]–0.07	0.1	0/20
Nickel	Qbt 2	13	8	[0.6]–6.0	6.58	0/13
	Qbt 1v	20	5	[0.6]–1.9	2.0	0/20
Potassium	Qbt 2	13	12	90–871	3500	0/13
	Qbt 1v	20	15	[89.9]–271	6670	0/20

Table 2.3-7 (continued)

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (mg/kg)[a]	BV (mg/kg)[b]	Frequency of Detects Above BV
Selenium	Qbt 2	13	1	[0.2]–[0.95]	0.3	5/13 DLs > BV
	Qbt 1v	20	1	[0.2]–[0.46]	0.3	1/20 5/20 DLs > BV
Silver	Qbt 2	13	0	[0.1]–[1.3]	1.0	1/13 DL > BV
	Qbt 1v	20	1	[0.1]–0.71	1.0	0/20
Sodium	Qbt 2	13	13	64.9–771	2770	0/13
	Qbt 1v	20	20	78.9–382	6330	0/20
Thallium	Qbt 2	13	1	[0.1]–1.7	1.1	1/13
	Qbt 1v	20	0	[0.1]–[0.5]	1.24	0/20
Vanadium	Qbt 2	13	12	0.94–3.8	17	0/13
	Qbt 1v	20	16	0.7–3.3	4.38	0/20
Zinc	Qbt 2	13	13	8.4–32.5	63.5	0/13
	Qbt 1v	20	20	7.0–45	84.6	0/20

[a] Values in square brackets indicate nondetects.
[b] Tuff BVs obtained from Ryti et al. (1998, 59730).

Chromium and thallium were detected at concentrations above their respective BVs in a single core sample; lead was detected at concentrations above its BVs in one sample from each of the two tuff units. Chromium and lead concentrations were not different from either tuff unit's background concentration (Qbt 2 and/or Qbt 1v) ($p>0.05$). Thallium was detected once in Qbt 2 core samples at a concentration (1.7 mg/kg) larger than the BV (1.1 mg/kg) but within the range of detected concentrations in Laboratory tuff background (0.05 mg/kg to 1.7 mg/kg). All the thallium DLs at MDA H were below the BV, but four of them were larger than the DLs observed in the Laboratory background samples. If these four larger DLs are treated as detects, then thallium concentrations at MDA H are not significantly different from background.

Antimony, cadmium, and selenium were detected above their respective BVs in single samples and had DLs above the Qbt 2 and/or Qbt 1v BVs, which are nominal analytical DLs. Silver and cyanide also had DLs above their respective BVs. The DLs reported above BVs occurred in blocks of samples from certain laboratory request numbers, implying that the elevated DLs are associated with a laboratory batch rather than a borehole location.

Cadmium was detected twice in Qbt 1v core samples with one concentration (0.52 mg/kg) above the BV (0.4 mg/kg, a nominal DL), and there were four DLs marginally above the BV (0.49 mg/kg to 0.5 mg/kg). There were no Qbt 1v Laboratory background samples analyzed for cadmium. If the MDA H samples are compared to the Laboratory background samples from the upper Qbt units (Qbt 2, Qbt 3, Qbt 4) all MDA H results are below the BV (1.63 mg/kg). If the four MDA H nondetects with elevated DLs are treated as detects (DL-mod), the modified statistical tests indicate that MDA H concentrations are less than those in background (both the quantile and slippage test p-values are greater than 0.99). Therefore, it is concluded that cadmium is not present at concentrations different from tuff background.

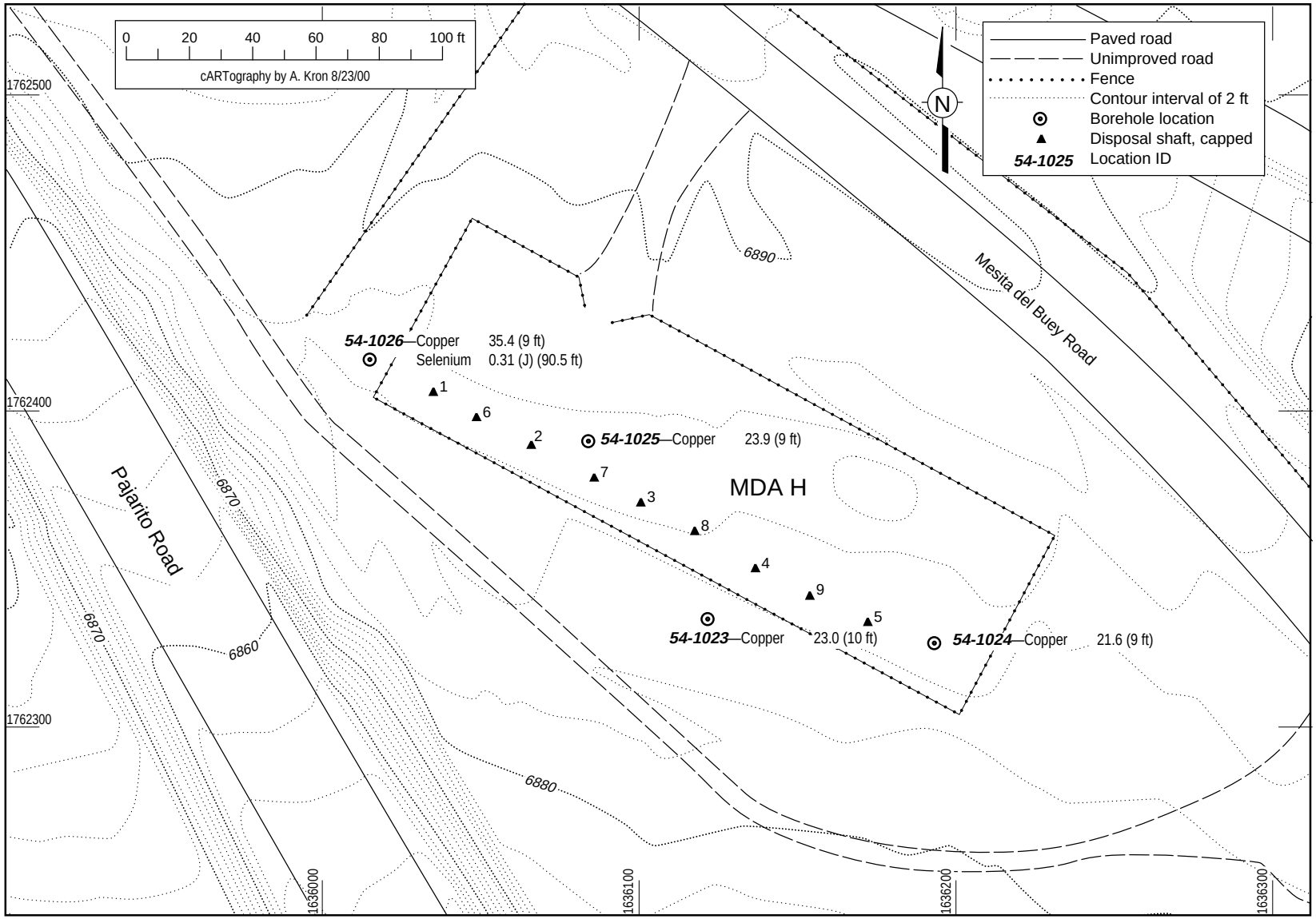

Figure 2.3-5. Detected concentrations of copper and selenium above BVs in borehole samples at MDA H

Six of 33 samples were analyzed for antimony by inductively coupled plasma emission spectroscopy (ICPES), resulting in high DLs (approximately 5 mg/kg) that are above the tuff BV (0.5 mg/kg, a nominal DL). The remainder of the samples was analyzed by inductively coupled plasma mass spectroscopy, the method used for the Laboratory background samples. If the ICPES results are removed as inadequate, all DLs in Qbt 1v are below the BV, and in Qbt 2, only one DL of 0.55 mg/kg and one detected concentration of 0.57 mg/kg remain above the BV. When ICPES results are excluded for Qbt 2 and the DLs larger than BVs are treated as detects (DL-mod), antimony concentrations are not significantly different from background (quantile test p-value = 0.12, slippage test p-value = 0.14) (Table E-3.2-2). Therefore, antimony in tuff at MDA H is not different from Laboratory tuff background.

Silver was not detected in core samples at MDA H. In Qbt 2, one sample had a DL (1.3 mg/kg) above the BV (1.0 mg/kg) but smaller than the detected concentration (1.9 mg/kg) in Laboratory background for this tuff unit. The detection rate at MDA H is lower than for Laboratory background, and the DLs are within the range of the Laboratory results (DLs plus detected concentrations). Silver is not considered elevated above background.

Cyanide was not detected in tuff samples at MDA H. The majority of the DLs were below the BV of 0.5 mg/kg (a nominal DL), but six DLs (1 mg/kg to 1.02 mg/kg) from one request number were approximately double the BV. Cyanide was not analyzed for in Laboratory background tuff samples, so there are no results for comparison. Therefore, cyanide is assumed to be different from background.

Selenium was detected once in Qbt 2 core samples and once in Qbt 1v core samples at concentrations (0.27 mg/kg and 0.31 mg/kg) approximately equal to the BV (0.3 mg/kg, a nominal DL) (Figure 2.3-5). In addition, there were 10 samples with elevated DLs (nine DLs between 0.42 mg/kg and 0.46 m/kg and a DL of 0.95 mg/kg). Only 15 Laboratory background tuff samples were analyzed for selenium, and none produced detected concentrations. There are insufficient Laboratory background tuff results for further comparisons, so selenium is assumed to be different from Laboratory background.

Radionuclide Comparison with Background or Fallout Values

Tuff samples were analyzed for gamma-emitting radionuclides and tritium, using gamma spectroscopy and liquid scintillation, respectively. The full-suite analyte list in the ER Project analytical services statement of work (LANL 1995, 49738) includes the decay series of the naturally occurring radionuclides, uranium-235, uranium-238, and thorium-232, as well as fission and activation products and their progeny. The primary radionuclides reliably measured by gamma spectroscopy include activation products (americium-241, cobalt-60, and sodium-22), fission products (cesium-134, cesium-137, europium-152, and ruthenium-106), and uranium-235. Uranium-235 is both naturally occurring and a potential historical contaminant from Laboratory operations. There were no QA/QC issues with the gamma-emitting radionuclide or tritium data that affected usability. Europium-152 results in two samples are qualified as not detected (U) because the results were less than five times the concentration of this analyte in the method blank. Table C-5.3-1 in Appendix C provides a comprehensive review of data quality.

Data indicate that tritium was the only radionuclide detected above its tuff fallout value, which is a nominal minimum detectable activity of 0.3 pCi/mL. Tritium was detected in 22 of 33 samples from the four boreholes and at all depths in boreholes 54-1023 and 54-1025. Tritium was detected at only four depths from approximately 40 ft to 70 ft in borehole 54-1026 and at only two depths from approximately 9 ft to 20 ft in borehole 54-1024. The concentrations ranged between a nondetect at certain depths in borehole 54-1026 and 777,000 pCi/mL in borehole 54-1025. Table 2.3-8 summarizes the radionuclide data for the tuff samples; Table 2.3-9 presents the detected tritium values by sample. Figure 2.3-6 presents the sample locations for the detected tritium concentrations.

Table 2.3-8
Frequency of Detected Radionuclides in Tuff Samples

Analyte	Media	Number of Analyses	Number of Detects	Concentration Range (pCi/g)a	Sediment Background or Fallout Value (pCi/g)b	Frequency of Detects or Detects Above Background or Fallout Value
Americium-241	Tuff	33	0	[-0.11–0.37]	0.05 [c]	0/33
Cesium-134	Tuff	17	0	[0.05–0.14]	No value	0/17
Cesium-137	Tuff	33	0	[-0.032–0.1]	0.1 [c]	0/33
Cobalt-60	Tuff	33	0	[-0.03–0.09]	No value	0/33
Europium-152	Tuff	16	0	[-0.07–0.23]	No value	0/16
Ruthenium-106	Tuff	33	0	[-0.44–0.67]	No Value	0/33
Sodium-22	Tuff	33	0	[-0.52–0.08]	No value	0/33
Tritium [d]	Tuff	33	22	[1.3]–777,000	0.3 [c]	22/33
Uranium-235	Qbt 2	6	0	[0.11–0.13]	0.09	0/6
	Qbt 1v	11	0	[0.11–0.13]	0.14	0/11

[a]Values in square brackets indicate nondetects.
[b]Tuff background and fallout values obtained from Ryti et al. (1998, 59730)
[c] Fallout values are nominal minimum detectable activities.
[d] Tritium values are in pCi/mL.

Tritium is present as a result of releases from tritium-contaminated waste in one or more of the shafts. Consequently, tritium is retained as a COPC at MDA H. The subsurface radionuclide data are discussed further in Appendix E; Table D-2.0-6 in Appendix D includes the complete data set. Section 3.1.2 discusses the spatial pattern of tritium concentrations.

Evaluation of Organic Chemicals

Tuff samples were analyzed for PCBs, pesticides, SVOCs, and VOCs. Acetone, benzene, benzoic acid, bis(2-ethylhexyl)phthalate, 2-butanone, butylbenzene (sec-), butylbenzene (n-), di-n-butylphthalate, dimethylphthalate, diethylphthalate, hexachlorobutadiene, methylene chloride, naphthalene, toluene, 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, and trichlorofluoromethane were qualified J (estimated) in one or more samples because the sample results were at concentrations below the analytical laboratory's EQLs. As a result, the concentrations for these organic chemicals have a greater uncertainty associated with the values. Several other organic chemicals (acetone, bis[2-ethylhexyl]phthalate, methylene chloride, and N-nitrosodimethylamine) were qualified as U (undetected) in some samples because of blank contamination. The detected organic chemicals in borehole samples at MDA H are shown on Figure 2.3-7. These QA/QC issues do not affect the data quality or usability of the organic chemical tuff data. Table C-5.2-1 in Appendix C provides a comprehensive review of data quality.

Table 2.3-9
Detected Tritium in Tuff Samples

Location ID	Sample ID	Sample Result (pCi/mL)	Media	Depth (ft)
54-1023	0554-95-0282	5890	Qbt 2	9.5–9.7
54-1023	0554-95-0284	37,927	Qbt 2	15.5–17
54-1023	0554-95-0286	44,535	Qbt 2	27–28.5
54-1023	0554-95-0288	34,409	Qbt 1v	37–38.5
54-1023	0554-95-0290	22,450	Qbt 1v	47–48.5
54-1023	0554-95-0292	12,005	Qbt 1v	57–58.5
54-1023	0554-95-0294	6644	Qbt 1v	67–68.5
54-1023	0554-95-0298	988	Qbt 1v	82.5–83.5
54-1024	0554-95-0321	320	Qbt 2	9–9.2
54-1024	0554-95-0323	3660	Qbt 2	18.5–20
54-1025	0554-95-0339	276	Qbt 2	9–9.2
54-1025	0554-95-0341	16,000	Qbt 2	17–18.8
54-1025	0554-95-0343	110,000	Qbt 2	28–29.5
54-1025	0554-95-0345	331,000	Qbt 1v	41–42.5
54-1025	0554-95-0347	777,000	Qbt 1v	51–52.7
54-1025	0554-95-0349	284,000	Qbt 1v	62–62.8
54-1025	0554-95-0351	32,200	Qbt 1v	71–71.8
54-1025	0554-95-0355	253	Qbt 1v	86–90
54-1026	0554-95-0304	429	Qbt 1v	41–41.5
54-1026	0554-95-0306	697	Qbt 1v	46.5–48
54-1026	0554-95-0308	589	Qbt 1v	58–60
54-1026	0554-95-0310	440	Qbt 1v	66.5–68

Eighteen organic chemicals were detected in one to six samples, with 14 of the detected organic chemicals reported only at concentrations below the EQLs. Acetone was detected in two samples at concentrations of 0.011 mg/kg and 0.016 mg/kg, which were slightly above the EQL of 0.01 mg/kg for these samples. Endosulfan sulfate was detected at a concentration of 0.000674 mg/kg, which is similar to the EQL of 0.000671 mg/kg. Trichlorofluoromethane was detected in six samples from borehole 54-1024 at concentrations ranging between 0.002 mg/kg and 0.007 mg/kg. The reported concentrations were slightly above the EQL of 0.005 mg/kg in four of the six samples. Bis(2-ethylhexyl)phthalate was detected in five samples at concentrations ranging between 0.038 mg/kg and 3.8 mg/kg. Two of the detected concentrations were above the EQL of 0.34 mg/kg (1.3 mg/kg and 3.8 mg/kg). Table 2.3-10 summarizes organic chemicals detected in the tuff at MDA H. Table D-2.0-5 in Appendix D includes the complete data set. Figure 2.3-7 presents the sample locations for the detected organic chemicals.

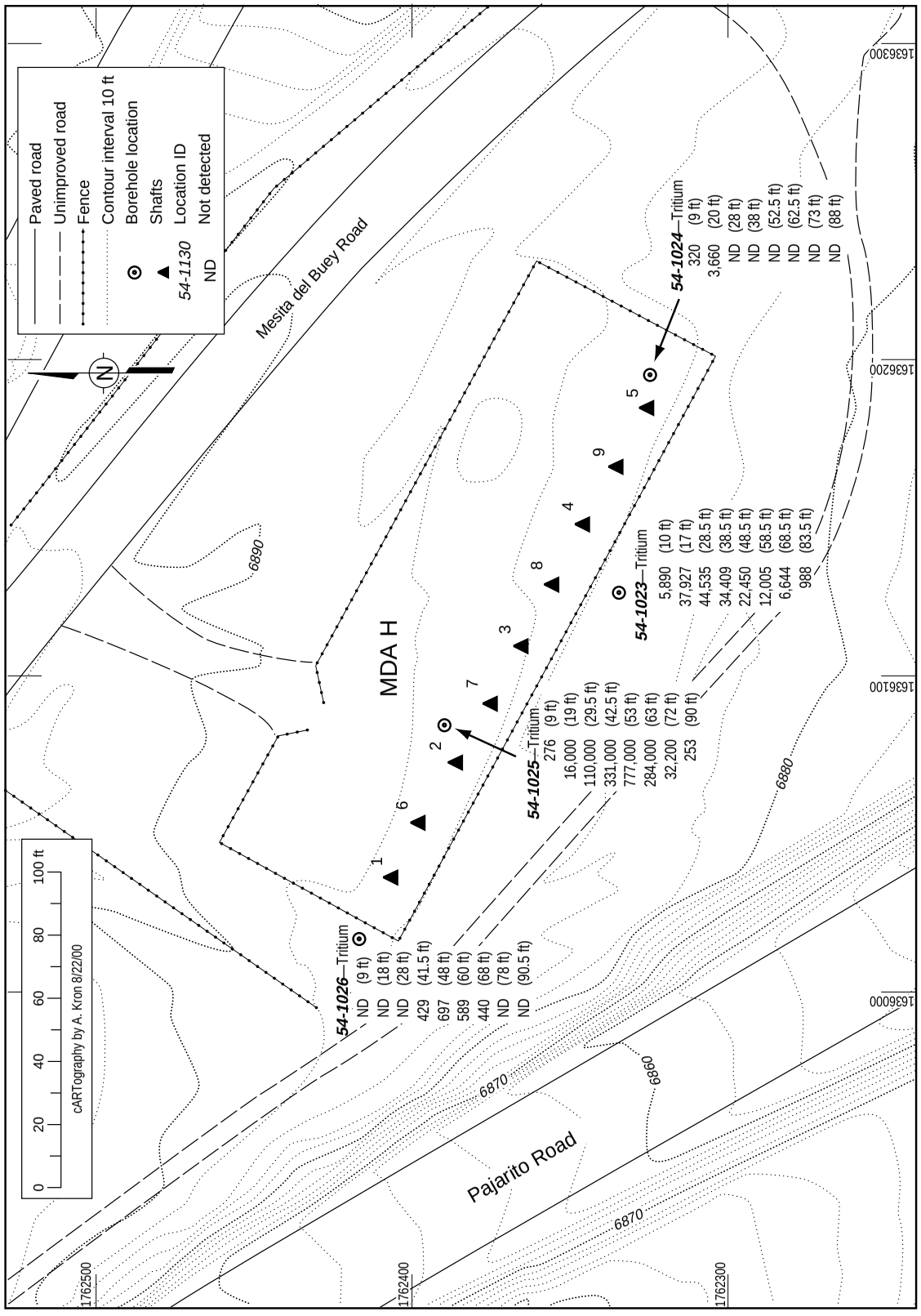

Figure 2.3-6. Detected concentrations (pCi/mL) of tritium in borehole samples at MDA H

Table 2.3-10
Frequency of Detected Organic Chemicals in the Tuff Samples

Suite or Analyte	Number of Analyses	Number of Detects	Concentration Range (mg/kg)*	EQL (mg/kg)	Frequency of Detects
SVOCs					
Benzoic acid	33	1	0.49–[3.5]	0.81-3.5	1/33
Bis(2-ethylhexyl)phthalate	33	5	[0.038]–3.8	0.04-0.34	5/33
Di-n-butylphthalate	33	6	0.043–[0.35]	0.33-0.35	6/33
Diethylphthalate	33	1	0.28–[0.35]	0.33-0.35	1/33
Dimethylphthalate	33	1	0.042–[0.35]	0.33-0.35	1/33
Naphthalene	33	1	0.001–[0.35]	0.005-0.35	1/33
Pesticide/PCB					
Endosulfan sulfate	33	1	[0.000671]–[0.00351]	0.000671-0.00351	1/33
VOCs					
Acetone	33	2	[0.002]–[0.025]	0.002-0.021	2/33
Benzene	33	1	0.003–[0.0052]	0.005-0.0052	1/33
Butanone [2-]	33	2	0.002–[0.021]	0.01-0.021	2/33
Butylbenzene [n-]	33	1	0.0013–[0.0052]	0.005-0.0052	1/33
Butylbenzene [sec-]	33	2	0.0011–[0.0052]	0.005-0.0052	2/33
Hexachlorobutadiene	33	1	0.002–[0.005]	0.005-0.35	1/33
Methylene chloride	33	3	0.002–[0.011]	0.003-0.011	3/33
Toluene	33	3	0.001–[0.0052]	0.005-0.0052	3/33
Trichlorobenzene[1,2,3-]	9	2	0.001–[0.005]	0.005	2/9
Trichlorobenzene[1,2,4-]	33	1	0.001–[0.005]	0.005-0.35	1/33
Trichlorofluoromethane	33	6	0.002–0.007	0.005-0.0052	6/33

*Values in square brackets indicate nondetects.

The reported concentrations of seven of the organic chemicals (benzoic acid, benzene, naphthalene, n-butylbenzene, hexachlorobutadiene, 1,2,4-trichlorobenzene, and endosulfan sulfate) detected in the tuff were at or below the EQLs; these chemicals were detected in less than 5% of the samples (1 of 33 samples). Because of the low level and infrequent detections, these organic chemicals may be false positives. According to waste disposal records, pesticides, VOCs, and SVOCs were not disposed of at MDA H. However, organic solvents may have been used to clean the classified shapes disposed of at the site. EPA guidance (EPA 1989, 8021) indicates that a low frequency of detection (e.g., 5% or less) is a mechanism to eliminate chemicals as COPCs, particularly if the available process knowledge indicates that the chemical(s) were not related to site activity. Despite these factors, benzoic acid, benzene, naphthalene, n-butylbenzene, hexachlorobutadiene, 1,2,4-trichlorobenzene, and endosulfan sulfate are retained as COPCs and carried forward to the screening assessment (Table 2.3-11).

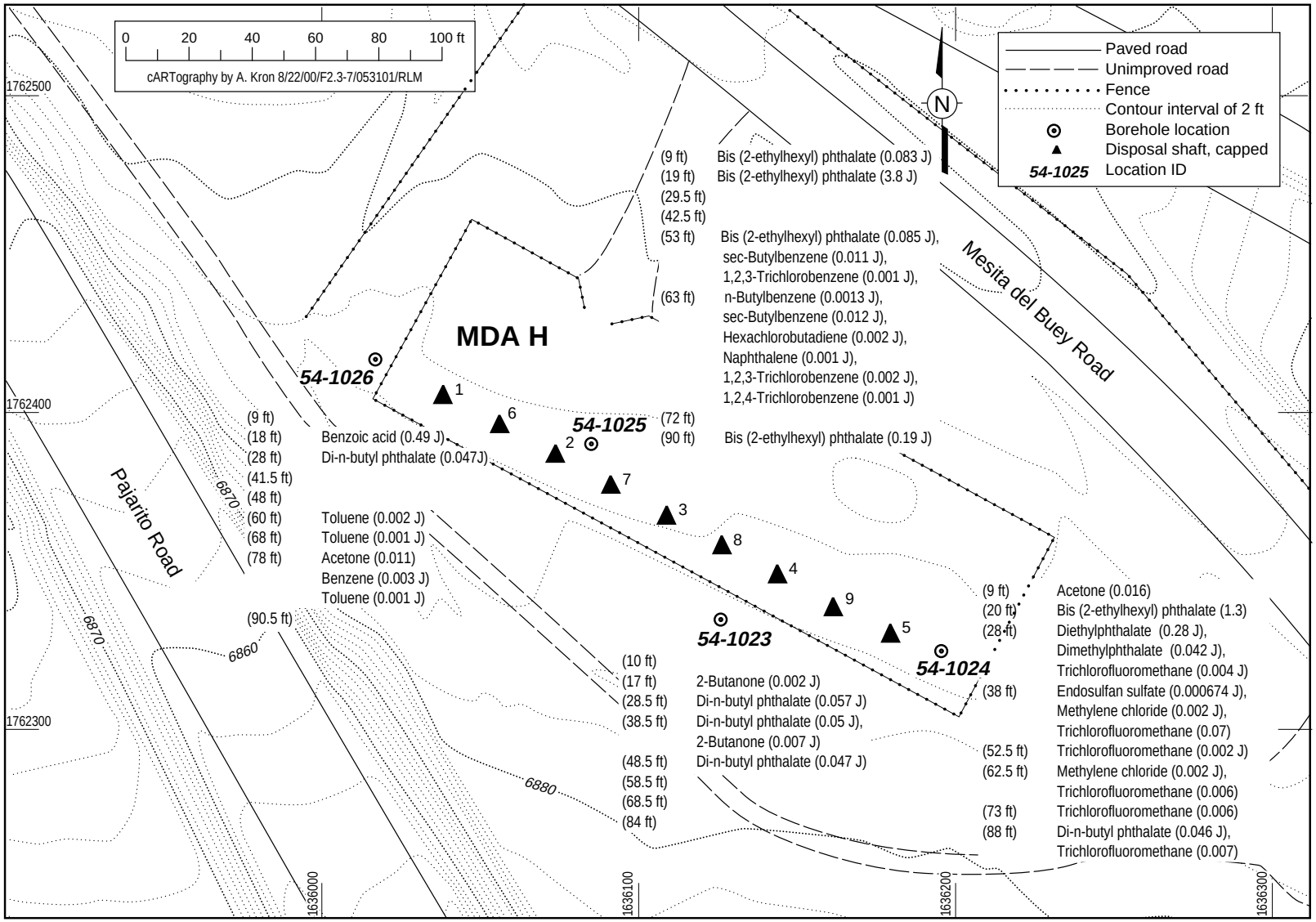

Figure 2.3-7. Detected organic chemicals (mg/kg) in borehole samples at MDA H

The majority of the remaining organic chemicals also were detected below the EQLs but are present in more than one sample and, in some cases, detected at consecutive depths within a borehole or boreholes. Because of the low-level detects whose concentrations are close to EQL values, there is a high degree of uncertainty related to actual levels present, and there is an increased likelihood of false positives. Although information indicates that they were not disposed of as waste, some of the waste may have been placed in plastic containers, i.e., bags or bottles, before disposal or were present as residual contamination. As a result, the phthalates are retained as COPCs. Trichlorofluoromethane is also retained because it was detected in pore gas, surface flux, and ambient air samples at MDA G. Therefore, the remaining eleven organic chemicals (acetone, 2-butanone, sec-butylbenzene, methylene chloride, toluene, 1,2,3-trichlorobenzene, diethylphthalate, dimethylphthalate, bis(2-ethylhexyl)phthalate, di-n-butylphthalate, and trichlorofluoromethane) are also retained as COPCs at MDA H (Table 2.3-11).

Table 2.3-11
Detected Organic Chemicals in Boreholes at MDA H

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Acetone	54-1024	0554-95-0321	0.016	Qbt 2	9–9.2
	54-1026	0554-95-0312	0.011	Qbt 1v	76.5–78
Benzene	54-1026	0554-95-0312	0.003(J)	Qbt 1v	76.5–78
Benzoic acid	54-1026	0554-95-0300	0.49(J)	Qbt 2	16.5–18.1
Bis(2-ethylhexyl)phthalate	54-1024	0554-95-0323	1.3	Qbt 2	18.5–20
	54-1025	0554-95-0339	0.083(J)	Qbt 2	9–9.2
	54-1025	0554-95-0341	3.8	Qbt 2	17–18.8
	54-1025	0554-95-0347	0.085(J)	Qbt 1v	51–52.7
	54-1025	0554-95-0355	0.19(J)	Qbt 1v	86–90
2-Butanone	54-1023	0554-95-0284	0.002(J)	Qbt 2	15.5–17
	54-1023	0554-95-0288	0.007(J)	Qbt 1v	37–38.5
n-Butylbenzene	54-1025	0554-95-0349	0.0013(J)	Qbt 1v	61–62.8
sec-Butylbenzene	54-1025	0554-95-0347	0.011(J)	Qbt 1v	51–52.7
	54-1025	0554-95-0349	0.012(J)	Qbt 1v	61–62.8
Diethylphthalate	54-1024	0554-95-0325	0.28(J)	Qbt 2	26–27.8
Dimethylphthalate	54-1024	0554-95-0325	0.042(J)	Qbt 2	26–27.8
Di-n-butylphthalate	54-1023	0554-95-0286	0.057(J)	Qbt 2	27–28.5
	54-1023	0554-95-0288	0.05(J)	Qbt 1v	37–38.5
	54-1023	0554-95-0290	0.051(J)	Qbt 1v	47–48.5
	54-1023	0554-95-0292	0.047(J)	Qbt 1v	57–58.5
	54-1024	0554-95-0337	0.046(J)	Qbt 1v	86–87.8
	54-1026	0554-95-0302	0.047(J)	Qbt 2	26.5–28
Endosulfan sulfate	54-1024	0554-95-0327	0.000674	Qbt 2	36–37.8
Hexachlorobutadiene	54-1025	0554-95-0349	0.002(J)	Qbt 1v	61–62.8

Table 2.3-11 (continued)

Analyte	Location ID	Sample ID	Sample Concentration (mg/kg)	Media	Depth (ft)
Methylene chloride	54-1024	0554-95-0327	0.002(J)	Qbt 2	36–37.8
	54-1024	0554-95-0331	0.002(J)	Qbt 1v	61–62.5
	54-1024	0554-95-0333	0.002(J)	Qbt 1v	71–72.8
Naphthalene	54-1025	0554-95-0349	0.001(J)	Qbt 1v	61–62.8
Toluene	54-1026	0554-95-0308	0.002(J)	Qbt 1v	58–60
	54-1026	0554-95-0310	0.001(J)	Qbt 1v	66.5–68
	54-1026	0554-95-0312	0.001(J)	Qbt 1v	76.5–78
1,2,3-Trichlorobenzene	54-1025	0554-95-0347	0.001(J)	Qbt 1v	51–52.7
	54-1025	0554-95-0349	0.002(J)	Qbt 1v	61–62.8
1,2,4-Trichlorobenzene	54-1025	0554-95-0349	0.001(J)	Qbt 1v	61–62.8
Trichlorofluoromethane	54-1024	0554-95-0325	0.004(J)	Qbt 2	26–27.8
	54-1024	0554-95-0327	0.007	Qbt 2	36–37.8
	54-1024	0554-95-0329	0.002(J)	Qbt 1v	51–52.5
	54-1024	0554-95-0331	0.006	Qbt 1v	61–62.5
	54-1024	0554-95-0333	0.006	Qbt 1v	71–72.8
	54-1024	0554-95-0337	0.007	Qbt 1v	86–87.8

2.3.5 Summary of COPCs at MDA H

Table 2.3-12 summarizes the results of the data review for channel sediments and tuff at MDA H. For each analyte listed, the table identifies which are retained as COPCs and which are eliminated from further consideration in the RFI, along with the rationale for that decision.

Table 2.3-12
Data Review Summary

Analyte	Medium	COPC (y/n?)	Rationale
Inorganic chemicals (except for copper, lead, cadmium, cyanide, and selenium)	Sediment and tuff	No	Inorganic chemical data were either less than the BVs or not different from background data sets.
Copper	Sediment	No	Not detected above sediment BV
	Tuff	Yes	Statistical tests found copper to be different from Qbt 2 background.
Lead	Sediment	No	Detected above the sediment BV in two samples but results are within the range of values in the background data set.
	Tuff	No	Not statistically different from tuff backgrounds
Cadmium	Sediment	Yes	DLs above the sediment BV and sediment background data set
	Tuff	No	Not statistically different from tuff backgrounds

Table 2.3-12 (continued)

Analyte	Medium	COPC (y/n?)	Rationale
Cyanide	Sediment	No	Not detected above the sediment BV
	Tuff	Yes	DLs above the tuff BV
Selenium	Sediment	Yes	DLs above the sediment BV
	Tuff	Yes	DLs above the tuff BVs
Radionuclides (except for tritium)	Sediment and tuff	No	Either not detected or detected below background or fallout value
Tritium	Sediment	Yes	Detected at a concentration above the fallout value in one sample
	Tuff	Yes	Detected in the majority of tuff samples at concentrations greatly exceeding the fallout value
Pesticides (except for methoxychlor and endosulfan sulfate)	Sediment and tuff	No	No other pesticides were detected in sediment or tuff.
Methoxychlor	Sediment	Yes	Detected at low concentrations in two samples
	Tuff	No	Not detected in any tuff samples
Endosulfan sulfate	Tuff	Yes	Detected in one tuff sample below the EQL
	Sediment	No	Not detected in any sediment samples
PCBs	Sediment and tuff	No	No PCBs were detected in sediment or tuff.
SVOCs (except for benzoic acid, bis(2-ethylhexyl)phthalate, diethylphthalate, dimethylphthalate, di-n-butylphthlalate, napthalene)	Tuff	No	Not detected in the tuff samples
	Sediment	No	Not analyzed for in sediment samples
Benzoic acid, bis(2-ethylhexyl)phthalate, diethylphthalate, dimethylphthalate, di-n-butylphthlalate, napthalene	Tuff	Yes	Detected in one to six tuff samples
	Sediment	No	Not analyzed for in sediment samples
VOCs (except for acetone, benzene, 2-butanone, n-butylbenzene, sec-butylbenzene, hexachlorobutadiene, methylene chloride, toluene, 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, trichlorofluoromethane)	Tuff	No	Not detected in the tuff samples
	Sediment	No	Not analyzed for in sediment samples
Acetone, benzene, 2-butanone, n-butylbenzene, sec-butylbenzene, hexachlorobutadiene, methylene chloride, toluene, 1,2,3-trichlorobenzene, 1,2,4-trichlorobenzene, trichlorofluoromethane	Tuff	Yes	Detected in one to six tuff samples
	Sediment	No	Not analyzed for in sediment samples

3.0 REVISED SITE CONCEPTUAL MODEL FOR MDA H

This section evaluates the COPCs to identify trends that may indicate a release from the PRS and the extent of the contamination resulting from the release. Results of the data review are used to reassess and revise, if necessary, the preliminary site conceptual model. The preliminary site conceptual model presented in Section 2 accurately depicts the potential release mechanisms throughout pathways at MDA H. The processes and events related to contaminant fate and transport in environmental media are discussed in Section 3.2. The nature and extent of contamination in sediment (i.e., accessible contamination) is the basis of the assessment of potential present-day risk (Section 4.2), while the characterization of the environmental fate of subsurface contaminants (i.e., currently inaccessible contamination) will be the basis of the future risk assessment associated with the corrective measures study (CMS) for MDA H.

3.1 Nature and Extent of Contamination

Channel sediment and subsurface tuff were sampled for contamination at MDA H. The data review in Section 2 indicated that COPCs include

- methoxychlor and tritium in channel sediment,
- copper and selenium in subsurface tuff,
- several organic chemicals in subsurface tuff, and
- tritium in subsurface tuff.

The source of the low-concentrations of methoxychlor contamination in the channel sediment is not known but detected concentrations indicate it is most likely the result of routine application. The source of the elevated copper concentrations at approximately 10 ft bgs is also not known. One possible explanation is natural variability**,** the result of remobilization by vapor-phase processes during welding/vitrification during emplacement (Stimac et al. 1996, 59362); similar enrichments of other inorganic chemicals in the Bandelier Tuff have been documented. The source of the low-level organic chemicals is unclear because VOCs and SVOCs were not disposed of as waste at MDA H. The source of tritium in the subsurface is the tritium-contaminated waste. The source for selenium in tuff is also unclear. The data from sediment and subsurface samples are discussed below.

The nature and extent analyses of MDA H RFI data corroborate the preliminary site conceptual model described in Section 2.3.2. Figure 2.3-1 illustrates that the source term and environmental transport components of the known sources of environmental contamination are

- vapor-phase release of tritium and perhaps organic chemicals from subsurface shafts and
- channel sediments contaminated with methoxychlor and tritium.

3.1.1 Surface Media Contamination

Four channel sediment samples were collected from the primary drainage at MDA H. This drainage runs to the southeast away from the site and is more of a depositional area than a well-defined, channeled drainage. No surface release or residual contamination was evident or documented for MDA H, which is consistent with the operational history and scale of activities at the site.

Nature and Extent of Inorganic Chemicals in Channel Sediment

Lead was the only inorganic chemical detected above the sediment BV in the drainage channel but was not different from the range of values in the background data set. Concentrations of lead were elevated

above the BV (19.7 mg/kg) by only 0.2 mg/kg to 1.6 mg/kg and decreased to below the BV in the farthest sample down drainage from MDA H. Cadmium and selenium were not detected in any channel sediment samples but had DLs above their BVs in three of four samples. The other inorganic chemicals in the channel sediment were either less than the BVs or not different from the background data sets.

Nature and Extent of Radionuclides in Channel Sediment

Tritium was detected above the fallout value in the sample nearest the fenced area of MDA H. Concentrations of tritium decreased to below the fallout value in samples collected farther down the drainage.

Nature and Extent of Organic Chemicals in Channel Sediment

Methoxychlor was detected in two of four samples at concentrations of 0.036 mg/kg and 0.04 mg/kg (Figure 2.3-4), approximately twice the EQL of 0.02 mg/kg. The extent of methoxychlor is not clearly defined by the channel sediment data because the farthest sample from the site had a detected concentration of 0.04 mg/kg, which is similar to the upstream concentration of 0.036 mg/kg. Because methoxychlor concentrations do not demonstrate an increase where detected, and methoxychlor is not related to disposal activities at MDA H, further sampling for extent is not warranted. Methoxychlor is further evaluated in the risk assessment, although its presence is being attributed to routine application of this pesticide either within TA-54 or elsewhere and not due to past waste disposal practices.

3.1.2 Subsurface Contamination

Nature and Extent of Inorganic Chemicals in Tuff

Copper was present at concentrations above the BV in the uppermost core sample (approximately 9 ft bgs) from each of the four boreholes at MDA H (Appendix E, Figures E-4.2-1 through E-3.2-1). Deeper samples had copper at concentrations less than the tuff BVs, thereby bounding the extent of copper. The presence of copper, which was not attributable to the subsurface disposal units, is likely due to a locally enriched zone in the tuff (Stimac et al. 1996, 59362). Cyanide and selenium were not detected in any of the borehole samples; however, 6 sample results (cyanide) and 10 sample results (selenium) in borehole 54-1024 had detection levels above the tuff BVs. Neither of these inorganic chemicals were detected in the surrounding boreholes, and analytical DLs were below the respective tuff BVs (0.5 mg/kg for cyanide and 0.3 mg/kg for selenium) in the remaining 20 sample results (cyanide) and 23 sample results (selenium). Therefore, there is no evidence of a release of cyanide or selenium, and further sampling for extent is not warranted.

Nature and Extent of Radionuclides in Tuff

Tritium was present at elevated levels in core samples (Figure 3.1-1). Transport of tritium through the subsurface is expected to be in the form of water vapor; therefore, tritium measured in core samples at MDA H is associated with residual moisture (pore water and water vapor) within the tuff. In each borehole, the tritium concentrations increased with depth to approximately 40 ft to 50 ft and subsequently decreased with depth. In addition, the highest tritium concentrations were reported in borehole 54-1025, which is located between shafts 2 and 7, while the other boreholes located away from the shafts had lower tritium concentrations. Additional subsurface data for tritium will be collected to obtain a clearer picture of its distribution and relationship to the shafts at MDA H.

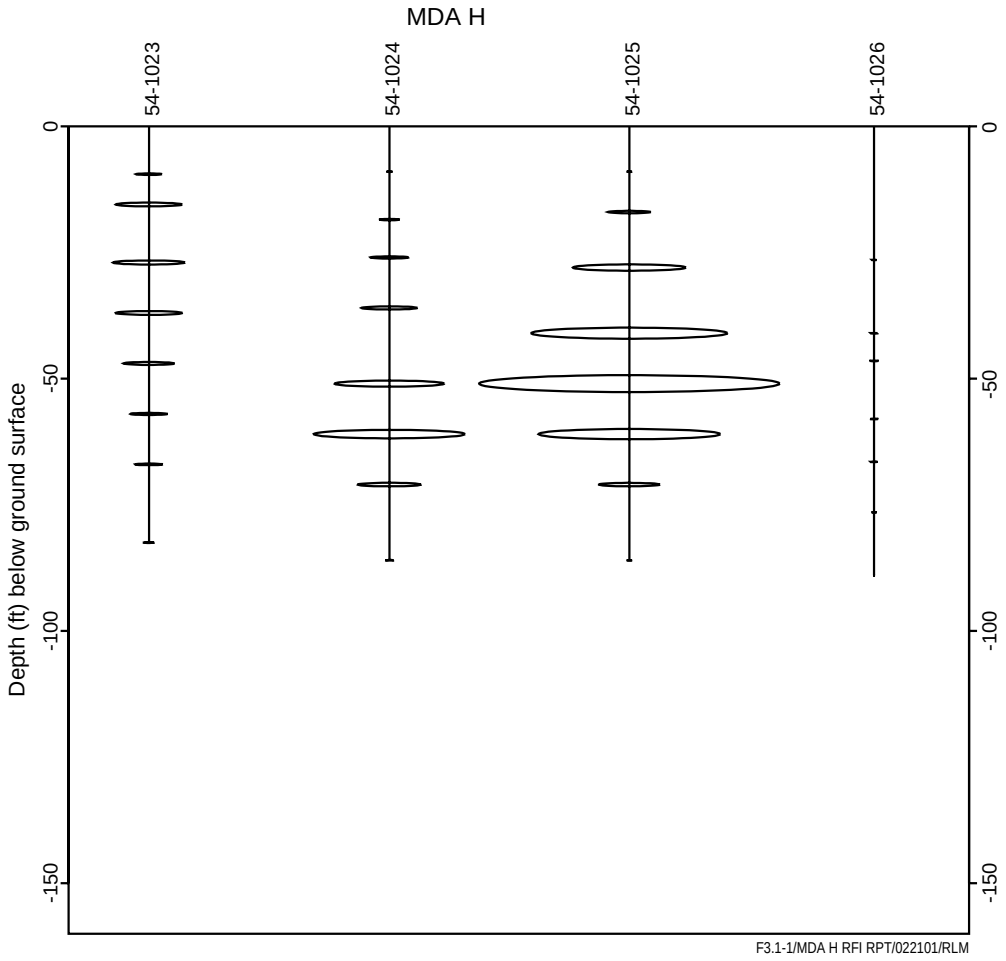

Figure 3.1-1. Tritium concentrations (pCi/mL) in borehole tuff samples at MDA H. Concentrations are proportional to the area enclosed by the oval and plotted at sampled depths (feet below ground surface) within the borehole.

Nature and Extent of Organic Chemicals in Tuff

Eighteen organic analytes were detected in 1 to 6 of the 33 core samples. Of these, 14 organic chemicals were detected at concentrations below the EQLs. Because the available site knowledge at MDA H indicates that pesticides, VOCs, and SVOCs were not disposed of and because of the infrequent detections (<5% of the samples) and the low-level concentrations (at or below the EQLs) reported, there is a strong likelihood that some of the 18 organic chemicals are not present or related to a release.

The vertical extent of the organic chemical concentrations is defined because, except for bis(2-ethylhexyl)phthalate and trichlorofluoromethane, one or more samples at greater depths than the detected concentrations were reported as not detected. The vertical extent is also defined for bis(2-ethylhexyl)phthalate because, although the deepest sample in borehole 54-1025 reported this chemical at 0.19 mg/kg, it is below the EQL of 0.33 to 0.34 mg/kg. Trichlorofluoromethane was only detected in borehole 54-1025 with concentrations ranging between 0.002 mg/kg and 0.007 mg/kg; it has an EQL of 0.005 mg/kg. The deepest sample from this borehole reported the concentration of

0.007 mg/kg, which is slightly above the EQL. Because of the low-level detection and the small difference from the EQL (0.002 to 0.003 mg/kg), no additional sampling for extent is warranted.

Lateral extent has also been defined by the available sample results, because most of the detected organic chemicals were reported in only one or two of the boreholes. The exception to this is di-n-butylphthalate, which was detected in three boreholes. However, the detected concentrations were below the EQL, so further sampling for extent is not warranted.

3.2 Environmental Fate

This section evaluates the RFI data for MDA H in the context of the revised site conceptual model; revisions to the model are based on the data analyses in Section 3.1. The revised model will serve as the basis for mathematical fate and transport models and will be used to calculate potential contaminant concentrations and potential migration of contaminants in the future. The RFI data are used to estimate present-day risks associated with contamination in potentially accessible environmental media at MDA H. The results of fate and transport models will be used to estimate future risks to hypothetical human and ecological receptors from processes and events that may make currently inaccessible subsurface contamination accessible. This subsequent analysis will be done as part of the CMS at MDA H.

3.2.1 Contaminant Release Mechanisms

The conceptual model of contaminant release from below-ground sources includes the following processes:

- dissolution of soluble contaminants in water percolating through the disposal shafts,
- excavation of particulate contaminants by animals burrowing into the disposal shafts,
- uptake of bioavailable contaminants by plants rooting into the disposal shafts, and
- diffusion of volatile or vapor-phase contaminants.

Of these processes, only the diffusion of tritium (as water vapor) is indicated by the RFI data for MDA H. Release rates depend upon the rate at which gaseous species are generated and how quickly the contaminants move through the waste matrix, backfill, and rock matrix. The measured surface fluxes at MDA H are expected to represent the maximum rates of release for tritium because the maximum tritium inventory (which produced the maximum diffusion gradient and release rate) occurred when the tritium-containing waste was disposed of. The maximum inventory has been reduced by both diffusion out of the waste and by radioactive decay. The remaining inventory of tritium will be reduced by a factor of two every 12 yr and will continue to diffuse at slower and slower rates.

3.2.2 Contaminant Transport Pathways

Conceptually, the pathways by which contaminants released from MDA H could be transported in environmental media include the following:

- unsaturated transport by pore water through the vadose zone beneath the shafts;
- solute or sediment transport by surface water of surface contamination into Pajarito Canyon;
- biotic uptake and redistribution of contamination;
- diffusion of volatile or vapor-phase contaminants from the ground surface into the ambient air, followed by dispersion in air; and
- atmospheric transport of vapor-phase volatile contaminants and contaminated surface soils to off-site locations.

All of these processes could apply to the tritium being released from MDA H, but dispersion in the atmosphere is the dominant transport pathway.

Because tritium is being released from MDA H as water vapor, it moves readily through various environmental media, including air, water, and plants. Tritiated water vapor will disperse most readily into air, unless there is sufficient water on the surface. If there is a high enough release rate of the tritium vapor and sufficient surface water, the tritium vapor that migrates to the surface may condense into the liquid phase. This condensed vapor could flow into Pajarito Canyon following the natural drainage off the mesa. In addition, tritium in water vapor may enter the food chain through root uptake, inhalation, dermal contact, and ingestion.

Tritium in water vapor will condense into the liquid phase if liquid water is present in sufficient amounts. This process is not physically possible at the generally low ambient moisture contents measured at MDA H but will be discussed here for completeness. If the moisture content in and around the disposal shafts at MDA H were to increase to 20% to 25%, the tritium could be transported vertically downward with water percolating through Mesita del Buey. Tritium may then reach the regional aquifer and be transported to downgradient locations east of Mesita del Buey in 120 yr to 240 yr (10 to 20 half-lives). The thickness of the unsaturated rock between the disposal shafts (i.e., the tritium source) and the regional water-supply aquifer is 900 ft. Under the existing measured moisture content (5%), water within the unsaturated rock on Mesita del Buey is not expected to recharge into the regional aquifer for thousands of years, if at all. Evidence supporting this statement includes natural tracer studies (Hollis et al. 1997, 63131, Appendix 2b), pore-water chemical analysis (Hollis et al. 1997, 63131, Appendix 2d), moisture-measurement analyses (Hollis et al. 1997, 63131, Appendix 2c), and groundwater flow calculations (Hollis et al. 1997, 63131, Appendix 3g). The moisture content in the rock beneath MDA H would have to increase by at least 10 times to significantly increase groundwater flow velocities toward the regional aquifer. The current moisture content of the Bandelier Tuff is <5%(Environmental Restoration Project 2001, 70035).

4.0 SITE ASSESSMENTS

4.1 Summary

Human health and ecological screening assessments were conducted for the COPCs identified in Section 2.3.4. These assessments did not indicate an unacceptable present-day risk to either group of receptors. The surface water assessment conducted for MDA H resulted in an erosion matrix score of 45.6, which indicates a moderate potential for erosion from this site (Appendix B). A groundwater assessment was not conducted as part of the RFI because sampling indicates that subsurface contamination from MDA H does not currently impact groundwater. Monitoring of the groundwater downgradient from TA-54 is being and will continue to be conducted to ensure contamination does not impact this medium. An underground storage tank assessment was not performed because it is not applicable to MDA H.

4.2 Screening Assessments

The human health screening assessment for MDA H is presented in Section 4.2.1 and the ecological screening assessment is presented in Section 4.2.2. The human health screening assessment follows the Hazardous Waste Bureau (HWB) Risk-Based Decision Tree (NMED 1998, 57761) and the current EPA Region 6 guidance (EPA 2000, 68410). The ecological screening assessment is based on the methodology described in Ryti et al. (1999, 64783).

4.2.1 Human Health

(a) Scoping

The current land use for this site is industrial, and the most likely exposed individuals are site workers. The site has restricted access (i.e., fenced and locked) and is not operational, so exposure is infrequent. The future land use is anticipated to remain industrial, i.e., under Laboratory control, for the foreseeable future (next 100 yr). If Laboratory control is eliminated, the area may become accessible to recreational as well as residential receptors. Because the residential land use is considered to be the most restrictive, although impractical under current site conditions, the potential present-day risks were evaluated using this scenario.

(b) Screening Evaluation

The COPCs identified in Section 2.3.4 were compared with the Laboratory's screening action levels (SALs) to determine if the chemicals were detected at concentrations of potential concern to human health. The SALs for nonradionuclides used in this evaluation were calculated based on NMED or EPA Region 6 guidance (NMED 2000, 68554; EPA 2000, 68410). The parameters used include the most current values available, as presented in EPA Region 6 and/or NMED guidance (EPA 2000, 68410; NMED 2000, 68554). The SALs used in this evaluation for radionuclide COPCs were calculated using the RESRAD computer code. All of the SALs reflect a residential exposure scenario where exposure is based on 24 hours per day and 350 days per year. The SALs are used to ensure a conservative evaluation of potential risk, and the data screening assessment follows the guidance provided by EPA Region 6 and NMED (EPA 2000, 68410; NMED 1998, 57761; NMED 2000, 68554). The comparison to SALs is conducted separately for carcinogens, noncarcinogens, and radionuclides. The SALs are equivalent to a 10^{-6} cancer risk for carcinogens, a hazard quotient (HQ) of 1.0 for noncarcinogens, and a dose of 15 mrem/yr for radionuclides. The maximum concentration of each COPC was compared with the SAL for carcinogens and for radionuclides and the 0.1 SAL for noncarcinogens because more than two noncarcinogenic COPCs have been identified.

Four carcinogenic chemicals (bis[2-ethylhexyl]phthalate, benzene, hexachlorobutadiene, and methylene chloride) were retained as COPCs in the subsurface tuff at MDA H. No carcinogenic chemicals were detected in the surface medium. The comparison of these COPCs to their respective SALs is presented in Table 4.2-1. The COPCs were detected below their SALs, and the total incremental cancer risk was 1×10^{-7}, which is below NMED's target risk level of 10^{-5}. This indicates that exposure to these COPCs does not present an unacceptable risk.

Table 4.2-1
Comparison of Carcinogenic COPCs to SALs

Analyte	Location ID	Sample ID	Depth (ft.)	Maximum Sample Value (mg/kg)	SAL (mg/kg)
Benzene	54-1026	0554-95-0312	76.5–78	0.003(J)	0.64
Bis(2-ethylhexyl)phthalate	54-1025	0554-95-0341	17–18.8	3.8	35
Hexachlorobutadiene	54-1025	0554-95-0349	61–62.8	0.002(J)	6.2
Methylene chloride	54-1024	0554-95-0327	36–37.8	0.002(J)	65

The noncarcinogenic COPC detected in the channel sediment was methoxychlor. Cadmium and selenium were also COPCs in the channel sediment because of elevated DLs. Copper, endosulfan sulfate, five SVOCs, and eight VOCs were retained as noncarcinogenic COPCs in the tuff samples. Cyanide and selenium were also COPCs in the tuff because of elevated DLs. The comparison of these COPCs to their respective SALs and 0.1 SALs is presented in Table 4.2-2. All of the COPCs were detected below 0.1 of their SALs indicating that exposure to either one or all of these COPCs does not present an unacceptable risk. The hazard index (obtained by dividing each concentration by the SAL and summing all quotients) for noncarcinogenic COPCs is 0.04, well below the NMED's target level of 1.0.

Tritium was the only radionuclide COPC identified in the channel sediment. The slightly elevated concentrations of 0.11 pCi/g is well below the SAL of 880 pCi/g. This SAL is based on a dose limit of 15 mrem/yr and derived according to LANL (2000, 69683). The concentration of tritium represents a dose of 0.002 mrem/yr.

Table 4.2-2
Comparison of Noncarcinogenic COPCs to SALs

Analyte	Location ID	Sample ID	Depth (ft.)	Maximum Sample Value (mg/kg)	SAL (mg/kg)	0.1 SAL (mg/kg)
Acetone	54-1024	0554-95-0321	9-9.2	0.016(J)	1600	160
Benzoic acid	54-1026	0554-95-0300	16.5-18.1	0.49(J)	100,000	10,000
Butanone[2-]	54-1023	0554-95-0288	37-38.5	0.007(J)	37000	3700
Butylbenzene[n-]	54-1025	0554-95-0349	61-62.8	0.0013(J)	140	14
Butylbenzene[sec-]	54-1025	0554-95-0349	61-62.8	0.0012(J)	110	11
Diethylphthalate	54-1024	0554-95-0325	26-27.8	0.28(J)	49000	4900
Di-n-butylphthalate	54-1023	0554-95-0286	27-28.5	0.057(J)	6100	610
Dimethylphthalate	54-1024	0554-95-0325	26-27.8	0.042(J)	100,000	10,000
Endosulfan sulfate	54-1024	0554-95-0327	36-37.8	0.000674(J)	370[a]	37
Naphthalene	54-1025	0554-95-0349	61-62.8	0.001(J)	53	5.3
Toluene	54-1026	0554-95-0308	58-60	0.002(J)	180	18
1,2,3-Trichlorobenzene	54-1025	0554-95-0349	61-62.8	0.002(J)	520[b]	52
1,2,4-Trichlorobenzene	54-1025	0554-95-0349	61-62.8	0.001(J)	520	52
Trichlorofluoromethane	54-1024	0554-95-0327	36-37.8	0.007	12000	1200
Methoxychlor	54-5132	AAB3131	0-0.67	0.04	310	31
Cadmium	54-5132	AAB3131	0-0.67	0.68(U)	70	7.0
Copper	54-1026	0554-95-0318	9-9.2	35.4	2800	280
Cyanide	54-1024	0554-95-0333	71-72.8	1.02(U)	1200[c]	120
Selenium	54-1023	0554-95-0282	9.5-9.7	0.95(U)	380	38

[a] No SAL is available for endosulfan sulfate, so the SAL for endosulfan is used as a surrogate based on similarity of structure.

[b] No SAL is available for 1,2,3-trichlorobenzene, so the SAL for 1,2,4-trichlorobenzene is used as a surrogate based on similarity of structure.

[c] The SAL used for cyanide is the value for free cyanide.

Tritium was the only radionuclide COPC detected in the tuff samples collected from the boreholes drilled in and around MDA H. Tritium concentrations reported in pCi/mL were converted to pCi/g based on the percent moisture for a given sample. The maximum reported tritium concentration of 777,000 pCi/mL is equivalent to approximately 1543 pCi/g based on a soil moisture of 0.2% for sample 0554-95-0347. This

concentration is approximately an order of magnitude greater than the SAL of 260 pCi/g and represents a potential dose of 59 mrem/yr. However, this concentration was reported at approximately 52.5 ft, which is below the depth at which potential exposure may occur for a resident. Residential exposure to subsurface contaminants (as represented by the SAL) exists only within the top 10 ft, which is approximately the depth at which a basement is located. The maximum concentration of tritium at 10 ft was approximately 5890 pCi/mL (sample 0554-95-0282), which is equivalent to approximately 182 pCi/g based on a soil moisture of 3% for this sample. This tritium concentration is less than the SAL of 260 pCi/g and represents a potential dose of approximately 7.0 mrem/yr.

(c) Uncertainty Analysis

The human health screening evaluation is a conservative comparison of the maximum detected concentrations of each COPC at MDA H with the respective SALs whose values are based on a residential exposure scenario. Because MDA H is currently under Laboratory control and is likely to remain so for at least the next 100 years, the most likely exposed individual is a site worker. This individual has a shorter exposure time, exposure frequency, and exposure duration than a resident (assumed to be 8 hr/day, 250 days/year, and 25 years versus 24 hr/day, 350 days/year, and 30 years for resident). As a result, the potential risk for the site worker is overestimated by the screening evaluation. MDA H is located in the southwestern corner of TA-54 and is not adjacent to San Ildefonso Pueblo land. The surface runoff from this MDA flows into Pajarito Canyon. Therefore, exposure of Native American receptors to detected concentrations of tritium and methoxychlor in drainage channel sediments from cultural use of pueblo land is unlikely, and potential risk is overestimated by this assessment.

Because copper, SVOC, VOC, endosulfan sulfate, and tritium contamination is only present in the subsurface tuff and MDA H is no longer in operation and has restricted access, it is unlikely that workers or nonworkers can currently be exposed to these contaminants under current conditions. The screening assessment, which is based on a residential scenario, assumes that exposure can occur because the below-ground portion of the house (0 ft to 10 ft) intrudes into the waste. This conservative assumption could not occur given the present-day conditions and land use and is not representative of current worker exposure. The only contaminants that a site worker or a nonworker could be exposed to are tritium and methoxychlor (in channel sediments), which are both below 0.1 SAL.

Because tritium tends to exist in the vapor phase, it may be diffusing from the surface at MDA H. No ambient air or surface flux measurements of tritium were collected at MDA H but were collected at MDA G. Amounts of tritium disposed of at MDA G are greater than those disposed of at MDA H. In addition, concentrations of tritium at MDA H are less than those detected at MDA G. For example, the maximum tritium concentration at MDA G is approximately 6,826,000 pCi/mL compared to a maximum tritium concentration of 777,000 pCi/mL at MDA H. The tritium plume at MDA G is also several times larger than the plume at MDA H. Therefore, an assessment of the ambient air tritium data at MDA G is an adequate, albeit indirect, way to determine whether a potentially unacceptable risk to site workers could be present at MDA H.

Tritium data collected in 1994 from ambient air station G-2 at MDA G were used in calculating the exposure point concentration (Environmental Surveillance Program 1998, 59904). Air station G-2 is adjacent to the tritium disposal shafts responsible for over 90% of tritium releases at MDA G and consistently has the highest measured tritium concentrations of any air-monitoring station at TA-54. Laboratory group ESH-17 (Air Quality Group, the Laboratory's air monitoring group), which maintains station G-2 and other ambient air stations in and around the Laboratory, reports the tritium data as the 95% upper confidence limit (UCL) of the mean (Table 4.2-3). The annual average tritium concentration for

1994 at air station G-2, calculated as the average of the 95% UCL values, is 1070 pCi/m^3 and was used to assess the ambient air exposure to tritium by site workers.

Table 4.2-3
1994 Ambient Air Tritium Concentrations at Station G-2 at MDA G

Sample Start Date	95% UCL (pCi/m3)	Sample Start Date	95% UCL (pCi/m3)
1/3/94	19.5	7/5/94	4917.1
1/18/94	16.7	7/18/94	3511.6
1/31/94	19.5	8/1/94	2763.5
2/14/94	59.4	8/15/94	1333.8
2/28/94	155.8	9/12/94	1819.2
3/14/94	180.9	9/26/94	983.9
3/28/94	399.5	10/11/94	568.6
4/11/94	577.9	10/24/94	303.7
4/25/94	555.1	11/7/94	56.0
5/9/94	1877.0	11/21/94	82.7
5/23/94	3241.2	12/5/94	57.4

An inhalation rate of 1.3 m^3/hr, which assumes an equal mix of light and moderate activity levels for a site worker throughout the workday, was used to assess the risk. This rate is the average of the hourly inhalation rates of 1.0 m^3/hr (light activity for adults) and 1.6 m^3/hr (moderate activity for adults) obtained from Table 5-23 in EPA's Exposure Factors Handbook (EPA 1997, 66596). An exposure time of 8 hr/day, an exposure frequency of 250 days/yr, and an exposure duration of 25 yr were assumed based on EPA's Standard Default Exposure Factors (EPA 1991, 56140). The internal dose conversion factor (DCF) for tritium was obtained from Federal Guidance Report No. 11 (EPA 1988, 50123). The DCF is used to convert the estimated adult daily intake of radionuclides over an exposure period to an annual committed effective dose equivalent. The calculated annual dose is assessed relative to a target dose of 15 mrem/yr, which is recommended by EPA for dose-based decisions (EPA 1997, 58693) and by DOE for the unconditional release of real property (DOE 2000, 67153).

Based on the exposure point concentration, the exposure parameters, and the equation presented in Appendix F, the annual tritium dose from ambient air to a site worker at MDA G is 0.19 mrem/yr. This annual dose is below the target limit of 15 mrem/yr. Based on the results of this assessment, site worker exposure to ambient air concentrations of tritium at MDA H is expected to be well below the 15 mrem/yr dose limit.

Tritium has a half-life of approximately 12.3 years. The tuff samples used in the screening assessment were collected in 1995, so approximately 20% of the tritium has decayed since that sampling event. As a result, the maximum concentration of tritium in tuff currently is approximately 1274 pCi/g or 49 mrem/yr (at 53 ft in borehole 54-1025), while the highest 10-ft concentration has been reduced to approximately 146 pCi/g or 5.6 mrem/yr. Based on the decay of tritium over time, the above estimates of dose have been overestimated in the assessments of data from MDA H.

(d) Interpretation of Screening Assessment Results for MDA H

The potential present-day risk to site workers from contaminants released to the surface and potentially accessible subsurface media is considered to be acceptable. Concentrations of noncarcinogenic COPCs do not exceed current SALs or 0.1 SALs, which represent a residential exposure. Similarly, carcinogenic COPCs did not exceed their respective SALs and had a total incremental cancer risk of approximately 1×10^{-7}. Comparison to EPA Region 6 human health medium-specific screening levels for an industrial worker indicates a similar relationship (EPA 2000, 68410). The maximum concentration of methoxychlor is several orders of magnitude below the EPA Region 6 industrial value for an outside worker of 3800 mg/kg. Comparison of the tuff COPCs to EPA Region 6 industrial worker values showed similar results.

The tritium concentrations in sediment are below the SAL and represent a dose of approximately 0.002 mrem/yr. The maximum tritium concentration in tuff exceeds the SAL and the recommended dose limit of 15 mrem/yr. However, this concentration of tritium as well as similarly elevated tritium concentrations are at depths that are inaccessible to current receptors (>10 ft) and do not pose a present-day problem to site workers. The maximum tritium concentration within the potential exposure depth of 10 ft for a resident was found to be less than 15 mrem/yr. In addition, an assessment of ambient air concentrations at MDA G was found not to result in an unacceptable dose to site workers, so by comparison, ambient air concentrations of tritium at MDA H should also not pose a problem to site workers.

Based on the human health assessment of RFI data collected at MDA H, there is no need for immediate action to reduce or eliminate exposure of site workers to contaminants.

4.2.2 Ecological

(a) Scoping

The scoping evaluation includes the problem formulation, which forms the conceptual basis for exposure and identifies the pathways of contaminant exposure to ecological receptors. The ecological scoping checklist for Mesita del Buey and TA-54, which forms the basis for the scoping, is presented in Appendix F. The checklist is for all of TA-54, including MDAs G and L, because the area contains similar habitat and receptors. Information from the checklist is summarized below. The ecological pathways conceptual exposure model for TA-54 is included as part of the checklist (Part C) and identifies the exposure pathways to plant and animal receptors at this site. The primary exposure pathways at TA-54 are dietary and respiratory uptake of contaminated surface and near-surface soil and sediment.

Biotic Associations

The top of Mesita del Buey has been developed as a result of site operations with some intrusion from grasses (e.g., Bouteloua spp.) and sage (Artemesia spp.). Predominant hillside tree and shrub species include ponderosa pine (Pinus ponderosa), piñon (Pinus edulis), one-seed juniper (Juniperus monosperma), Rocky Mountain juniper (Juniperus scropulorum), Gambel oak (Quercus gambelii), wavyleaf oak (Quercus undulata), mockorange (Philadelphus microphyllus), mountain mahogany (Cercocarpus montanus), New Mexico hops (Ptelae trifoliata), sumac (Rhus spp.), and sage. Predominant hillside ground cover includes various grasses (e.g., Bouteloua spp.) and some forbs, as well as mosses and lichens in rocky areas. Banar (1996, 58192) presents a detailed account of the species present in and around TA-54. Scoping activities revealed abundant invertebrates, reptiles, mammals, birds, and plant life on the hillsides. The hillside areas of Mesita del Buey have fully intact terrestrial biotic communities and therefore include a full suite of potential terrestrial receptors.

MDA H is managed in a way that limits ecological receptors to invasive plants, small mammals, birds, and invertebrates. The mesa top is fenced off from the surrounding hillsides and is managed intensively to limit access to the area by large ground-dwelling animals (e.g., deer, elk, and mountain lions); some limitations may also apply to foxes, coyotes, raccoons, bobcat, and other medium-size mammals. Although the mesa top and hillsides differ in community composition and character because of area management, each of the terrestrial functional feeding groups expected on the Pajarito Plateau are likely found in and around MDA H.

Potential habitat for T&E species is found on the mesa top and/or hillsides of Mesita del Buey for a number of species (Banar 1996, 58192, Chapter 6). However, habitats for only two species (peregrine falcon [Falco peregrinus] and the spotted bat [Euderma maculatum]) are found with high frequency in the area. Neither of these species has been observed to roost or nest in the area. In addition, the peregrine falcon was delisted as a federal T&E species by the US Fish and Wildlife Service in August 1999.

Suspected Contaminant and Physical Effects on Biotic Media

To evaluate the impacts of potential contamination from subsurface releases at MDA H, efforts were made to distinguish between effects that may be contaminant related and those that are related to natural physical processes or manmade disturbances, i.e., operational activities. On Mesita del Buey, there are no causal signs of contaminant-related effects. Contaminants are known to have reached biotic populations at MDA G from sampling of vegetation (Fresquez et al. 1997, 62346), small mammals (Bennett et al., 1997, 62342), and invertebrates (Haarmann and Fresquez, 1998, 62351). However, there have been no demonstrated population-wide or individual toxicological or ecological effects.

The only obvious ecological effect from TA-54 operations, including MDA H, is from the physical disturbance of the area as a result of operational activities. The area around MDA H shows some signs of erosion because of the removal of vegetation and past disposal activities. Sheet flow and rill erosion from stormwater runoff from the site has occurred and has resulted in the formation of a drainage channel leading into Pajarito Canyon to the southeast of MDA H.

Data Adequacy

The results of the data quality assessment for the samples collected from MDA H are presented in Appendix C. There were no QA/QC issues associated with the sampling and analyses that affected the sufficiency and quality of the data for decision-making purposes at this site. Therefore, the data are considered adequate for this assessment and representative of the contamination present at MDA H.

The nature and extent of contamination at MDA H are summarized in Section 3. Tritium was detected slightly above background and methoxychlor was detected in the channel sediments below MDA H, while cadmium and selenium had elevated DLs in the sediment data set. These chemicals are included in the screening evaluation even though the data do not indicate a subsurface or surface release from this MDA. The subsurface COPCs were not evaluated by the screening assessment because they were detected at depths greater than 5 ft. Below this depth, there are no complete pathways to ecological receptors.

(b) Screening Evaluation

The results of ecological scoping indicate that eight terrestrial receptors are appropriate for numerical screening against contaminant concentrations at MDA H. These receptors cover 11 trophic categories identified for the Pajarito Plateau (Ryti et al. 1999, 64783) and include

- a generic plant,
- a soil-dwelling invertebrate (represented by the earthworm),
- the American robin (avian insectivore, avian omnivore, and avian herbivore),
- the American kestrel (avian insectivore and carnivore),
- the deer mouse (mammalian omnivore),
- the vagrant shrew (mammalian insectivore),
- the desert cottontail (mammalian herbivore), and
- the gray fox (mammalian carnivore).

In addition to these commonly assessed receptors, the little brown myotis bat is included in this screening evaluation because it is a surrogate for the spotted bat, a T&E species. The spotted bat is an insectivorous mammal, and the little brown myotis bat is a receptor that models the effects of contaminants bioaccumulated from sediments to insects to aerial insectivores. A high fraction of its diet is emergent aquatic insects, as the habitats surrounding water are favorite foraging areas. Although aquatic insects are not present in the vicinity of MDA H, the drainage channel leading from this site does flow into Pajarito Canyon where small wetland areas are present. Contaminants transported from MDA H (specifically tritium and methoxychlor) by way of surface runoff may be deposited in these wetland areas and result in exposure to the bat. Concentrations of tritium and methoxychlor reported in the drainage channel are representative of concentrations that may be present in the wetlands.

The numerical screening evaluation compared media-specific ESLs for each receptor with concentrations of contaminants detected at the site. ESLs are derived based on the approach presented in Ryti et al. (1999, 64783) and the ECORISK database (LANL 1998, 67822). These sources include all relevant information necessary to calculate HQs and hazard indices, including concentration equations, dose equations, bioconcentration factors, transfer factors, and toxicity reference values. Radiological ESLs are derived on a radiation dose basis, while those for nonradiological chemicals are determined on a toxicological dose basis (Ryti et al. 1999, 64783). For wildlife, toxicological studies were used to determine the maximum contaminant exposure at which no adverse effect was observed (Ryti et al. 1999, 64783). This critical exposure level may vary greatly because of population-based variations in individual weight, diet, reproductive status, and phenology. In the case of terrestrial organisms, ESLs were developed to reflect an adverse effect on an average, nongravid, adult individual of a particular species (EPA 1993, 59384, p. 7). ESLs are designed, therefore, to be protective of specific organisms and may only be used to infer a potential for risk to receptors. The ESLs used in the screening evaluation at MDA H were obtained from the ECORISK database (LANL 1998, 67822).

COPCs at MDA H evaluated by the ecological screening assessment process included methoxychlor, tritium, cadmium, and selenium (Section 2.3.4). The maximum detected concentrations of each COPC were used in the comparison because the number of samples collected was insufficient to calculate a representative 95% UCL of the mean. As previously mentioned, COPCs from depths greater than 5 ft are not included in the screening evaluation because they are not available to ecological receptors.

The minimum ESL for each COPC was compared with the maximum detected concentration or DL for that contaminant; the HQ was calculated by dividing the concentration/DL by the ESL (Table 4.2-4). An HQ equal to or greater than 0.3 was used as a threshold to identify chemicals of potential ecological concern (COPECs) and determine which chemicals should be evaluated further (Ryti et al. 1999, 64783). Based on this initial comparison, tritium and methoxychlor are eliminated from further evaluation because the maximum HQs are less than 0.3, while cadmium and selenium are identified as COPECs because the maximum HQs are greater than 0.3. These COPECs are evaluated further by calculating HQs for each COPEC/receptor combination using the maximum DL. Table 4.2-5 presents a summary of this evaluation.

The maximum HQ for selenium is above 1.0, and the maximum HQ for cadmium is less than 1.0 (Ryti et al. 1999, 64783). Because of the conservative nature of the ESLs, this indicates little if any potential for adverse impacts to receptor populations. In addition, neither of these inorganic chemicals was detected in the sediment samples at the concentrations used in the screening nor at lower concentrations. The other HQs (Table 4.2-5) are approximately 1.0 or less for selenium and approximately 1/3 or more below the maximum HQ for cadmium, further indicating that these COPECs do not present a potential for adverse impacts to receptor populations. The potential for adverse impact to T&E species (peregrine falcon and spotted bat) is also unlikely because the maximum HQs for the kestrel (100% meat diet) and the little brown myotis bat, which are surrogates for the T&E species, are 0.001 and 0.06, respectively, for cadmium, and 0.1 and 0.8, respectively, for selenium (Table 4.2-5).

Table 4.2-4
Comparison of Maximum Detected Concentrations or DLs of COPCs in the Channel Sediment with Final ESLs

Analyte	Maximum Concentration (mg/kg)	Minimum ESL (mg/kg)	Receptor	HQ
Cadmium	0.68(U)	1.0	Plant	0.7
Tritium	0.11 pCi/g	21,000 pCi/g	Plant	0.000005
Methoxychlor	0.04	8.4	Shrew	0.005
Selenium	0.95(U)	0.5	Plant	1.9

Table 4.2-5
HQ Calculations for Terrestrial Receptors at MDA H

Analyte	Plant		Invertebrate		Deer Mouse		Vagrant Shrew		Desert Cottontail		Gray Fox	
	ESL	HQ	ESL	HQ	ESL	HQ	ESL	HQ	ESL	HQ	ESL	HQ
Cadmium	1.0	0.7	10	0.1	8.4	0.1	7.2	0.1	18	0.06	730	.001
Selenium	0.5	1.9	7.7	0.1	1.2	0.4	0.91	1.0	4.1	0.2	34	0.03
Analyte	**Robin (insectivore)**		**Robin (omnivore)**		**Robin (herbivore)**		**Kestrel (omnivore)**		**Kestrel (100% meat diet)**		**Little Brown Myotis Bat**	
	ESL	HQ	ESL	HQ	ESL	HQ	ESL	HQ	ESL	HQ	ESL	HQ
Cadmium	5.9	0.2	6.1	0.2	6.3	0.2	45	0.02	720	.001	10	0.1
Selenium	1.1	0.9	1.4	0.7	2.0	0.5	7.7	0.1	37	0.06	1.2	0.8

Note. Units for ESLs are mg/kg.

(c) Uncertainty Analysis

Toxicity information is available for several receptors for each of the COPCs. The numbers of receptors for each COPC were six for methoxychlor and nine for cadmium, tritium, and selenium. The receptors, for which toxicity information is available, includes several trophic categories for each COPC. The available ESLs are, therefore, considered adequate to determine whether there is a potential for ecological impacts from exposure to the COPCs.

ESLs for vertebrate terrestrial receptors were based on similar species and derived from experimentally determined no-observed adverse effect levels, lowest-observed adverse effect levels, or lethal doses that

caused 50% mortality in the population. Receptor-specific data for estimating potential ecological risk are often lacking; therefore, species-specific toxicological effect data from laboratory animals must be extrapolated for wild receptors. Data from laboratory studies are sometimes limited because the studies often evaluate single chemical exposures in isolated and controlled conditions using a single exposure pathway. Additionally, laboratory-controlled toxicological studies are often performed on individuals obtained from artificial and maintained populations. Wild organisms are concomitantly exposed to a variety of stressors and risk-drivers, thereby, increasing the potential from synergistic and antagonistic physiological effects. Wild populations are also considered to be more genetically diverse than laboratory animals, making wild populations, as a whole, potentially less sensitive to chemical exposure. The uncertainties associated with these differences may result in an underestimation or overestimation of potential risk.

The assumptions used in the ESL derivations were conservative and not necessarily representative of actual conditions. The assumptions include maximum chemical bioavailability, maximum receptor ingestion rates, minimum body weight, 100% home-range exposure, and additive effects of multiple COPCs. This tends to result in conservative estimates of the ESLs, which may lead to an overestimation of the potential risk to a receptor.

The chemical form of the COPCs was not determined as part of this RFI. This is largely a matter of limitations of analytical quantitation of individual chemical species. Toxicological data are typically based on the most toxic and bioavailable chemical species, which are not likely found in the environment. Inorganic, organic, or radionuclide chemicals are generally not 100% bioavailable to receptors in the natural environment because of adsorption to matrix surfaces (e.g., soil and sediments) or rapid oxidation or reduction changes that render harmful chemical forms unavailable to biotic processes. Inorganic chemicals and methoxychlor tend to adsorb to soil particles making them less available to receptors. Therefore, the exposure and subsequent toxicity of inorganic chemicals and methoxychlor to receptors is likely overestimated by the screening assessment. Tritium, which tends to exist in the water-vapor phase, is more readily available to receptors. Although the high bioavailability of tritium may result in an underestimation of the exposure and toxicity to receptors, the tritium concentrations were an order of magnitude or more below the ESL.

The screening evaluation was performed using the maximum detected concentration of each COPC at MDA H. Maximum concentrations were used because only a few data points were available for some media, and there were often a large number of nondetects associated with the COPCs. As a result, the exposure of individuals within a population was evaluated using this specific concentration; the concentration was assumed to be constant throughout the exposure area. This results in an overestimation of the potential risk because concentrations of COPCs varied across the site as well as with depth, as illustrated by the sample data (Figures 2.3-3, 2.3-4, 2.3-5, 2.3-6, and 2.3-7).

ESLs are not currently available for methoxychlor for either the plant or the soil-dwelling invertebrate. Because these receptors are in close contact with the soil, they may be susceptible to these chemicals. In addition, the concentrations of methoxychlor were approximately two orders of magnitude or more below the ESLs, including the ESLs for the shrew and mouse, which are also in close contact with the soil.

The shallowest depth from which borehole samples were collected and analyzed was approximately 10 ft below ground surface. The lack of data between the surface and 10 ft results in some uncertainty with respect to the concentrations of COPCs actually encountered by receptors within the top 5 ft of the site. However, the top 6 ft of the shafts were backfilled with crushed tuff and covered with concrete and soil, so no contaminants are present in the shafts at this depth. As a result, concentrations of contaminants in the top 6 ft or so should be negligible, and the concentrations at 9 ft to 10 ft should be representative of the remaining 3 ft to 4 ft between the crushed tuff layer and the shallowest borehole sample. MDA H does

have some plant cover, and there is evidence of burrowing animals (primarily pocket gophers); however, the plants inhabiting the site are invasive grasses and weeds and are not deep rooted, while the gopher burrows are not likely to reach very deep because of the tuff layer, which is difficult to penetrate.

The tritium data from all four boreholes demonstrates an increase in concentrations from approximately 10 ft to approximately 50 ft and a subsequent decrease in concentrations below 50 ft (Figure 2.3-6). Based on this relationship of tritium concentration and depth, it is appropriate to assume that the concentrations of tritium from 0 ft to 10 ft are less than the concentrations from 10 ft to 50 ft. In addition, as mentioned earlier, the top 6 ft of the shafts were backfilled, so no contaminants are present at this depth. Therefore, using the maximum detected concentration of tritium at 10 ft to simulate tritium levels in the 0-ft- to 5-ft-depth interval overestimates the actual concentration of tritium available at shallower depths. Comparison of the tritium level of 5890 pCi/mL in sample 0554-95-0282, which is equivalent to approximately 182 pCi/g based on a soil moisture of 3% for this sample, to the minimum ESL (21,000 pCi/g for the plant) indicates that there is no potential risk to ecological receptors from tritium in the subsurface. Tritium concentrations in the channel sediment were reported to be similar to or less than the fallout value, indicating that there has not been a surface release of tritium at MDA H.

Copper concentrations above background were only detected at a depth of 10 ft, and concentrations at deeper depths were all less than tuff background concentrations. In addition, concentrations in the channel sediment were less than the BV for sediment, indicating that there was not a surface release of copper at MDA H. The single layer of elevated copper may indicate natural variability within the tuff. Other heterogeneities (enrichments) of particular inorganic chemicals have been documented in the Bandelier Tuff and are the result of remobilization by vapor-phase processes during welding/devitrification (Stimac et al. 1996, 59362). Copper is one of the inorganic chemicals that can be affected by these processes. Therefore, elevated copper concentrations detected in the tuff may not be related to a release from the shafts. In addition, concentrations of copper from 0 ft to 10 ft are likely less than those reported at 10 ft because the top 6 ft of the shafts are backfilled as described above.

No vapor-phase or surface flux data for tritium are available. As a result, the exposure of burrowing animals to vapor-phase tritium in burrows cannot be assessed directly. If a burrow intrudes into the tritium plume and does not vent to the surface, the concentration of tritium within the burrow space will eventually equilibrate with the concentration in the surrounding tuff. As shown in the screening evaluation, the maximum detected tritium concentration in tuff (1593 pCi/g) is less than the minimum ESL (21,000 pCi/g for the plant). The maximum tritium concentration is also below the ESLs for the earthworm (100,000 pCi/g) and the shrew (2,700,000 pCi/g), which represent below-ground receptors. Based on this comparison, the concentration of tritium in burrow spaces does not pose the potential for adverse impacts to ecological receptors.

(d) Interpretation of Screening Assessment Results for MDA H

The ecological screening assessment of MDA H indicates that the COPCs identified by the data review (Section 2.3.4) do not pose a potential for adverse ecological impacts to terrestrial receptors. The screening evaluation, which used conservative ESLs for nine representative receptors, showed that HQs were slightly above 1.0 for the plant for selenium but 1.0 or less for all other receptors. The HQs for the other COPECs were less than 1.0 for all receptors, including the surrogates for the T&E species. In addition to the low HQs, cadmium and selenium were not detected in any of the sediment samples. Based on the results of the ecological screening assessment, there is no current potential for adverse impact to ecological receptors at MDA H.

4.3 Surface Water Assessment

The Laboratory's ER Project has developed a procedure to assess sediment transport and erosion concerns at individual PRSs. It provides a basis for prioritizing and scheduling action to control erosion of potentially contaminated soils at specific PRSs. The procedure is a two-part evaluation. Part A is a compilation of existing PRS analytical data, site maps, and knowledge-of-process information. Part B is an assessment of erosion and sediment transport potential at the PRS. Erosion potential is numerically rated from 1 to 100 using a matrix system. PRSs that score greater than 60 have a high erosion potential. MDA H (PRS 54-004) has score of 45.6, indicating a moderate erosion potential. The surface water assessment was conducted on December 20, 2000. The calculated erosion matrix score includes 3.6 for site setting, a runoff score of 35.0, and a run-on score of 7.0. The surface water assessment document is attached to Appendix B. The assessment found that there was no debris in the watercourse. Surface water runoff from MDA H terminates to the southeast in Pajarito Canyon. Rill erosion is occurring at one location along the southern fence line, and there is minor run-on to the site from the northwest portion. There are no structural or operational factors that might affect the site hydrology.

4.4 Groundwater Assessment

A groundwater assessment was not conducted for MDA H because sampling indicates that subsurface contamination from MDA H does not currently impact groundwater. Groundwater is being investigated according to the Laboratory's Hydrogeologic Work Plan (LANL 1996, 55430). Groundwater data from the unsaturated zone monitoring at MDA G, the regional saturated zone future monitoring at R-22, and the ongoing TA-54 groundwater investigation will be evaluated to determine any impact to groundwater quality.

4.5 Underground Storage Tank

Not applicable

4.6 Other Assessments

No other assessments were conducted.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The objectives of the MDA H RFI were to

- determine if a release of hazardous waste has occurred from the MDA;
- characterize the nature and extent of contaminant releases, if any, to the environment in accordance with the Operable Unit 1148 RFI work plan (LANL 1992, 7669) and subsequent modifications to the work plan (Appendix G);
- evaluate the potential ecological and human health risks posed by exposure to contaminants under present-day conditions, and
- recommend, if necessary, additional investigations to reduce uncertainties associated with contaminant behavior and to ensure that contaminants do not pose an unacceptable future risk to human and ecological resources.

Data analyses in Section 3 showed a release of tritium (in the form of water vapor) from subsurface shafts. Methoxychlor was detected at very low concentrations in channel sediments in the drainage leading from MDA H but does not appear to be related to a release. Other COPCs (copper, selenium, and

the organic chemicals that were detected in the tuff) also do not appear to be related to a release. Data gathered during the RFI identified the nature and partial extent of contamination in surface and subsurface media. Results from human health and ecological impact assessments, based on the preliminary RFI data, show that MDA H poses no unacceptable present-day risk to human health and the environment. The collection of additional data described below will result in a reevaluation of the present-day risk at MDA H in an addendum to this RFI report.

During the review of the draft RFI report for MDA H, NMED-HWB personnel identified data gaps regarding the extent of tritium and VOC contamination in the subsurface and of tritium in air. Therefore, the following activities are recommended to address the remaining data gaps, fully characterize the lateral and vertical extent of contaminant releases, and update or revise impact assessments.

- Collection of additional subsurface samples to further define the lateral extent of tritium and organic chemical contamination from borehole 54-1023 and from newly drilled boreholes.
- Installation of an air-monitoring station adjacent to MDA H to monitor for tritium in air.
- Collection of a sediment sample near sample location 54-5132 at the interface of the alluvial sediments and bedrock to collect data where all the sediment accumulated over the years.
- Evaluation and incorporation of groundwater data from the unsaturated zone monitoring at MDA G, the regional saturated zone at R-22, and the ongoing TA-54 groundwater investigation.

An addendum to this report will summarize the 2001 data and assess if there are any changes to the present-day risk assessment.

In addition, NMED-HWB determined that a RCRA CMS was needed because "…contaminants at this site may present a threat to human health and the environment over the lifetime of the waste" (Young 2000, 68569). Therefore, the determination to proceed with a CMS is based on a potential for future adverse human health or environmental impacts from the radionuclides in accordance with DOE Orders 435.1, "Radioactive Waste Management," and 5400.5, "Radiation Protection of the Public and the Environment." NMED-HWB agreed that further investigation of the site to fill remaining data gaps could be completed as part of the CMS.

The MDA H CMS will assess the need for and the design features of alternative remedies to reduce potential future adverse impacts from hazardous wastes, if any, and radionuclides buried in the subsurface. During the CMS, remediation alternatives that address potential future unacceptable conditions will be identified and evaluated, such as in-place containment, removal, and no action. After completion of the CMS, one or more of the alternatives will be recommended for implementation.

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Cy (w/enc.):
M. Backsen, E/ER, MS M992
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